The Distribution of Landings of British Columbia Salmon in Relation to Size of the Commercial Fishing Fleet. IV. Chinook Salmon

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June 1984

Canadian Technical Report of Fisheries and Aquatic Sciences No. 1292

85-2501/

Canadian Technical Report of Fisheries and Aquatic Sciences

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Cat. No. Fs 97-6/1292E ISSN 0706-6457

Correct citation for this publication:

Beacham, T. D. 1984. The distribution of landings of British Columbia salmon in relation to the size of the commercial fishing fleet. IV. Chinook salmon. Can. Tech. Rep. Fish. Aquat. Sci. 1292: 71 p.

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ABSTRACT

Beacham, T. D. 1984. The distribution of landings of British Columbia salmon in relation to the size of the commercial fishing fleet. IV. Chinook salmon. Can. Tech. Rep. Fish. Aquat. Sci. 1292: 71 p.

The distribution of landings of chinook salmon in relation to the size of the commercial fishing fleet was investigated on an annual basis during 1967-1981. An average of 1492 gillnetters accounted for 90% of the total landings in any year. Eighty-three percent of the vessels participating in the gillnet fishery landed less than 100 chinook salmon annually. The top 50% of the vessels participating in the gillnet fishery accounted for 87% of the total annual landings. An average of 299 purse seiners accounted for 90% of the landings, and 52% of the seiners landed less than 200 pieces annually. The top 50% of the seiners accounted for 82% of the total annual landings. An average of 1439 trollers accounted for 90% of the total annual landings of chinook salmon. About 71% of all vessels participating in the troll fishery for chinook salmon landed less than 400 pieces annually. The top 50% of the vessels that landed troll-caught chinook salmon accounted for 91% of the total annual landings.

Key words: British Columbia, catch, chinook salmon, exploitation, gillnet, seine, troll

RESUME

Beacham, T. D. 1984. The distribution of landings of British Columbia salmon in relation to the size of the commercial fishing fleet. IV. Chinook salmon. Can. Tech. Rep. Fish. Aquat. Sci. 1292: 71 p.

On a étudié sur une base annuelle, de 1967 à 1981, la distribution des débarquements de saumon quinnat en fonction de la taille de la flottille de pêche commerciale. Chaque année, 90% des débarquements étaient effectués, en moyenne, par 1,492 bateaux de pêche aux filets maillants. De ces bateaux, 83% ont débarqué moins de 100 quinnats annuellement et les premiers 50% se sont appropriés 87% des prises totales annuelles. Une moyenne de 299 senneurs dont 52% ont débarqué moins de 200 poissons annuellement, ont effectué 90% des débarquements. Les premiers 50% de ces senneurs ont pêché 82% des prises totales annuelles. Une moyenne de 1,439 bateaux de pêche à la traîne ont été responsables de 90% des débarquements totaux annuels de saumon quinnat. Environ 71% de tous les bateaux à la traîne participants ont capturé moins de 400 poissons annuellement et les premiers 50% se sont appropriés 91% des prises totales annuelles.

Mots-clés: Colombie-Britannique, prise, saumon quinnat, exploitation, filet maillant, senne, ligne traînante

INTRODUCTION

The British Columbia commercial fishing fleet for salmon is currently too large, given the amount of salmon to be harvested and the efficiency of the fleet to do so. A commission on Pacific fisheries policy suggested that the salmon fleet be reduced to half of its present capacity over a 10-year period (Pearse 1982). This reduction in fleet capacity was suggested to be accomplished by a buy-back program. In an evaluation of a buy-back program, a committee was established to recommend in part the number of vessels that should be present in the fishery after the buy-back program is completed. The recommendation for the salmon fleet was for 400 seiners, 1467 trollers, and 2208 gillnet plus gillnet/troll combination vessels (Cruickshank et al. 1982). This would represent a 25% decrease in the number of seiners (from 532 to 400), 12% for trollers (from 1667 to 1467), and 12% from gillnet plus gillnet/troll combination vessels (from 2508 to 2208). However, it is uncertain what the degree of redistribution of the landings would be if the suggested number of vessels were removed from the fleet.

Incomes are distributed non-uniformly among fishermen (Sinclair 1978). Landings of salmon may also be distributed non-uniformly among different vessels participating in the salmon fishery. The present report details the distribution of landings of chinook salmon (Oncorhynchus tshawytscha) in relation to the size of the commercial fishing fleet and indicates the degree of redistribution of the landings that may be expected when decisions on fleet size are made.

An analysis was conducted in order to determine the distribution of landings in relation to the number of commercial fishing vessels for each species of Pacific salmon and for all species combined on a weight basis. This analysis was conducted for each of the major gear components in the British Columbia salmon fishery (gillnet, seine, and troll). When the distribution of landings of Pacific salmon in relation to the size of the commercial fleet is known, decisions can be made on the level to which the fleet could be reduced. The present report deals with the distribution of landings of chinook salmon during 1967-1981 in relation to the number of commercial fishing vessels in British Columbia and it is the fourth in a series of reports on the distribution of landings of Pacific salmon.

MATERIALS AND METHODS

The information upon which the distribution of landings in relation to the size of the commercial fishing fleet is determined is derived from sales-slips. Wong (1983) has described the procedure used in recording and editing the information contained on the sales-slip. Summarized briefly, sales-slips are generated when the catch is delivered for processing or sold, and information on the commercial fishing vessel (CFV) license number, gear, area, period, and weight or numbers of species caught is recorded. Sales-

slips lacking numbers of salmon landed but containing the weight landed are adjusted for numbers by dividing the weight by the mean weight of the particular species, area, and gear that are applicable.

The analysis in the present study depended upon compiling the annual landings by species for each commercial fishing vessel in the three major gear classifications: purse seiner, gillnetter, and troller. This should be confidential information, so that, as outlined by Wong (1983), original commercial fishing vessel license numbers are converted to different codes by a standard method each year, so that it is not possible to relate catches to a specific vessel without authorization. The analysis for this report used solely the transformed license numbers.

The analysis of the sales-slips revealed that in some instances, there would be only 1 sales-slip for a particular license number in one of the three gear classes in a year. These were assumed to be errors in recording the license number, and were deleted in the subsequent description of the distribution of the catch. The distribution of catch was summarized in two ways, the first being by the number of vessels in a particular gear class, and the second by the percentage of vessels in a particular gear class. The number of vessels that landed salmon in a particular gear class was not constant during 1967-1981, so that both methods were used to describe the catch distribution.

Landings from combination vessels (gillnet and troll gear) were assigned to the gear used to catch the salmon sold at the time that the sales-slip was generated. Landings from a combination vessel would thus appear in both the troll and gillnet gear classes as appropriate.

The salmon sales-slip data tapes upon which the present analysis is based were derived from Wong (1983). The number of purse seiners recorded landing chinook salmon in 1980 and 1981 was greater than the number of licensed vessels. It was assumed that errors were made in recording the gear of some commercial fishing vessel license numbers so that the maximum number of purse seiners in 1980 and 1981 was set at the number of licenses (532). For the analysis in this report, landings of chinook salmon by purse seine vessels were arranged in descending order and landings from the 533rd vessel onwards were deleted. This removed those vessels with the smallest annual landings of chinook salmon.

The top 200 vessels in terms of landings for a particular species were recorded annually for trollers and gillnetters during 1967-1981. The top 100 seiners were recorded annually during 1969-1981. When the top vessels were identified in a particular year, it was possible to examine how many were also in the top category in previous and subsequent years. For example, once the top 200 gillnetters for chinook salmon had been identified in 1975, it was possible to examine how many of these same vessels were in the top 200 gillnetters for chinook salmon in 1973 or 1981. This analysis was conducted in order to determine whether or not some vessels were successful on a continuing basis.

The analysis of distribution of landings in relation to the number of vessels in each fleet component first proceeded by determining annual landings for each species for each vessel in the three gear categories.

Vessels were then sorted in descending order based upon the size of the landings for each species. Once the total catch and the total number of vessels that participated in the fishery for each species were determined, it was then possible to calculate the proportion of the catch that was taken by different numbers of vessels and also different proportions of the fleet. The number and percentage of vessels that landed different numbers of salmon were also calculated.

RESULTS

GILLNET COMPONENT

The landings of chinook salmon by gillnetters have ranged from 110 thousand to 258 thousand annually during 1967 to 1981 (Table 1). The gillnet share of the total landings of chinook salmon has declined relative to the other gears when landings are considered on a coast-wide basis. Prior to 1970 gillnetters accounted for at least 20% of the coast-wide landings, but their share of the total landings declined to less than 10% in 1980 and 1981.

The distribution of total landings of chinook salmon in relation to the number of vessels participating in the gillnet fishery was examined on an annual basis during 1967-1981 (Appendix A, Tables A1-A15). This 15-year distribution of the landings in relation to the number of vessels in the fishery is summarized in Figure 1. An average of 1492 vessels accounted for 90% of the total landings in any year. As the gillnet landings of chinook salmon have declined, so have the number of vessels that account for a fixed portion of the landings (Table 2). The largest gillnet landings of chinook salmon were recorded in 1970, and in that year 1925 vessels accounted for 90% of the total landings. By 1981, 1260 vessels accounted for 90% of the total gillnet landings. The top 1159 vessels accounted for an average of 80% of the total landings in any year (Table 2). The increase in landings in moving from 80 to 90% of the total landings was accompanied by an increase in the number of vessels by 29%. In examining the number of vessels that account for 100% of the landings as compared with 90%, the number increased 99% from 1492 to 2973 vessels.

The frequency of total landings per vessel was also investigated on an annual basis. An average of 83% of the vessels participating in the gillnet fishery for chinook salmon landed less than 100 chinook salmon annually during 1967-1981 (Table 3). About 5% of the vessels landed more than 200 chinook salmon annually. The top 50% of the vessels participating in the gillnet fishery during 1967-1981 accounted for an average of 87% of the total annual landings (Table 4). Recall that 90% of the total gillnet landings of chinook salmon was accounted for by 1492 vessels.

The repeatability of success in landing chinook salmon was examined by identifying the top 200 gillnetters in each year during 1967-1981 and tallying how many of these 200 were in the top 200 in all other years. The

results are illustrated in Table 5. With an average of 2973 vessels in the fishery and under the assumption of a random distribution of the top 200 vessels in all years except the one in which they were the top 200 vessels, one would expect an average of (200/2973) x 200 = 13 vessels to appear by chance. If 20 or more appear, there is a significant statistical association ($x^2 = 3.84$, $P < 0.05$), which indicates that vessels successful in one year were also successful in previous and successive years. For example, if one examines the top 200 vessels in 1974, there were a significant number of these vessels that were also in the top 200 vessels during 1967-1981 (Table 5). This analysis indicates that successful chinook salmon gillnet vessels tend to be successful on a continuing basis.

SEINE COMPONENT

The landings of chinook salmon by purse seiners have ranged from 62 thousand pieces in 1968 to 196 thousand pieces in 1977 (Table 1). The proportion of the total landings accounted for by purse seiners has increased from less than 10% prior to 1970 to between 10 and 15% subsequently.

The distribution of total landings of chinook salmon in relation to the number of purse seiners was examined on an annual basis during 1967-1981 (Appendix B, Tables B1-B15). The distribution of the landings in relation to the number of purse seiners participating in the fishery is summarized in Figure 2. On an average basis between 1967 and 1981, about 299 purse seiners accounted for 90% of the total landings in any year. However, in 1968, when 62 thousand pieces were landed, 252 vessels accounted for 90% of the total landings, and in 1977, when 196 thousand pieces of chinook salmon were landed by purse seiners, 334 vessels accounted for 90% of the total (Table 6). The top 227 vessels accounted for an average of 80% of the total landings in any year. In moving from 80 to 90% of the total landings of chinook salmon, the number of vessels increased from 227 to 299. This increase in catch was accounted for by a 32% increase in the number of vessels. In examining the number of vessels that account for 100% of the landings, the number was an average of 481, an increase of 61% over the number of vessels accounting for 90% of the landings.

The frequency of total landings per vessel was also investigated on an annual basis. About 52% of the purse seiners participating in the chinook salmon fishery landed less than 200 pieces annually (Table 7). An average of 9.5% of the vessels landed in excess of 600 pieces annually. The top 50% of the vessels participating in the fishery during 1967-1981 accounted for an average of 82% of the total annual landings (Table 4). Recall that 80% of the total purse seine landings of chinook salmon was previously noted to be accounted for by the top 227 purse seiners.

The annual repeatability of success in landing chinook salmon in the purse seine fishery was examined by identifying the top 100 seiners in each year during 1969-1981 and tallying how many of these 100 were in the top 100 in all other years (Table 8). Using an average of 481 vessels in the fishery, one would expect, under the assumption of a random distribution of the top 100 vessels in all years except the one in which they were the top 100 vessels,

that an average of (100/481) x 100 = 21 vessels to appear by chance. If 30 or more vessels appear, this indicates that vessels successful in one year (the diagonal of 100s in Table 9) were also successful in the year for which 30 or more vessels are counted ($x^2 = 3.84$, $P < 0.05$). For example, the top 100 seiners for chinook salmon in 1978 were also more successful for chinook salmon during 1975-1979 than one would expect by chance (Table 9). There is some evidence to indicate that successful chinook salmon purse seine vessels tend to be successful for a range of years.

TROLL COMPONENT

Landings of troll-caught chinook salmon have ranged between 754 thousand pieces (1968) and 1.27 million pieces (1971) (Table 1). Trollers have usually accounted for in excess of 70% of the annual commercial landings.

The distribution of total landings of chinook salmon in relation to the number of vessels that used troll gear to land chinook salmon was examined on an annual basis during 1967-1981 (Appendix C, Tables C1-C15). The distribution of landings of chinook salmon in relation to the number of vessels using troll gear that participated in the fishery is summarized in Figure 3. On an average basis between 1967 and 1981, about 1439 trollers accounted for 90% of the landings in any year (Table 9). Trollers had the greatest landing of chinook salmon in any year during 1967-1981 in 1971, and in that year, 1501 vessels accounted for 90% of the total landings. The poorest landings were in 1968, when 909 trollers accounted for 90% of the total landings. On an average basis between 1967 and 1981, the top 1058 vessels accounted for 80% of the landings in any year. In increasing from 80 to 90% of the total troll-caught landings of chinook salmon, the average number of vessels that accounted for the catch increased from 1058 to 1439, an increase of 36%. An average of 3065 vessels accounted for 100% of troll-caught chinook salmon, an increase of 113% over the number of vessels accounting for 90% of the landings.

The frequency of total landings per vessel was also investigated on an annual basis during 1967-1981. An average of 237 vessels landed more than 1000 chinook salmon annually (Table 10). Of the vessels that used troll gear to land chinook salmon, about 53% of these vessels landed less than 200 troll-caught chinook salmon annually. The top 50% of the vessels that landed troll-caught chinook salmon during 1967-1981 accounted for an average of 91% of the total annual landings (Table 4).

The annual repeatability of success in landing chinook salmon in the troll fishery was examined by identifying the top 200 vessels in each year during 1967-1981, and tallying how many of these 200 were in the top 200 in all other years (Table 11). Using an average of 3065 vessels in the fishery, one would expect, under the assumption of a random distribution of the top 200 vessels in all years except the one in which they were the top 200 vessels, that an average of (200 x 200/3065) = 13 vessels to appear by chance. If 20 or more vessels appear, this indicates that the vessels successful in one year

(the diagonal of 200s in Table 11) were also successful in the year in which 20 or more vessels were counted ($x^2 = 3.84$, $P < 0.05$). For example, the top 200 trollers in 1977 were also more successful for chinook salmon during 1969 to 1981 than one would expect by chance alone (Table 11). This analysis suggests that successful troll vessels for chinook salmon tend to be successful for a number of years.

DISCUSSION

The number of vessels accounting for 90% of the harvest of British Columbia chinook salmon under a similar management policy as was instituted during 1967-1981 was found to be about 1492 gillnet vessels, 299 purse seine vessels, and 1439 trollers. Reducing the size of the commercial fleet to the previously noted levels would not significantly reduce the overall landings of chinook salmon nor the exploitation rates on the species. With less competition among vessels of each gear class under a reduced fleet size, the exploitation rate of an average vessel could increase to the extent that overall exploitation rates on chinook salmon stocks could increase. Exploitation rates must necessarily continue to be regulated by restrictions on fishing time and locations.

The number of vessels of each gear class that the present analysis indicates would be sufficient to harvest British Columbia chinook salmon is less than the recommendations of a British Columbia fleet rationalization committee of 2208 gillnetters, 400 seiners, and 1467 trollers (Cruickshank et al. 1982). The present analysis suggests that the number of seiners could be reduced by 44% (from 532 to 299), gillnetters and combination gillnet/troll vessels by 41% (from 2508 to 1492), and trollers by 14% (from 1667 to 1439) and the landings of chinook salmon would not be significantly reduced. It is assumed that the least effective vessels would be removed from the fishery. The present analysis deals only with chinook salmon landings, but the results for the other species are similar. For example, an average of 1320 gillnetters and 305 seiners accounted for 90% of the landings for each gear type of pink salmon in British Columbia during 1967-1981. An average of 1290 gillnetters and 290 seiners accounted for 90% of the landings for each gear type of chum salmon. An average of 1855 gillnetters, 288 seiners, and 777 trollers accounted for 90% of the landings of sockeye salmon (Beacham 1984a,b; unpublished data).

Reduction of fleet size to the levels suggested by the fleet rationalization committee (Cruickshank et al. 1982) were projected to result in rapid rises in income to the vessels remaining in the commercial fleets. The present analysis for chinook salmon suggests that if the least efficient vessels are removed from the fleet, mean landings of chinook salmon per vessel will not increase and thus mean gross income per vessel remaining in the fleet will not increase, as long as total catches do not increase and prices remain stable.

The present report outlines the number of vessels necessary to harvest British Columbia chinook salmon in the commercial fleet if current management practices are continued and gear distributions of catch are maintained. It does not consider the social implications of reduction of fleet size and these should be considered in the establishment of targets for a reduced size of the commercial salmon fleet in British Columbia.

ACKNOWLEDGMENTS

Mr. Fred Wong made available the data upon which the distribution of landings of salmon in relation to fleet size was determined. Mr. Bruce Bernard designed the computer software for the graphics in this report. Mr. Bernard's assistance in this project was invaluable, and the study could not have been conducted in its present form without his considerable talents.

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Table 1. Commercial landings (thousands of pieces) of chinook salmon in British Columbia, 1967-1981.

Year	Gillnet	Seine	Troll	Total
1967	256	72	760	1089
1968	215	62	754	1031
1969	175	72	809	1056
1970	258	136	785	1180
1971	214	109	1270	1593
1972	215	110	1223	1549
1973	180	150	1090	1420
1974	152	137	1178	1467
1975	166	142	1103	1412
1976	169	129	1245	1543
1977	188	196	1108	1492
1978	147	188	1033	1368
1979	147	186	996	1329
1980	114	134	1023	1272
1981	110	155	868	1134

Table 2. Number of gillnetters accounting for varying percentages of the total gillnet landings of chinook salmon in British Columbia, 1967-1981.

Percent of total landings	Year															
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1967-81
10	59	47	57	59	46	42	39	38	41	34	35	38	35	32	28	42
20	150	124	145	144	119	110	111	98	107	92	101	96	90	78	70	109
30	266	225	252	249	215	200	208	184	193	169	185	176	163	138	124	196
40	406	350	383	378	337	314	331	301	301	266	290	281	253	215	199	307
50	576	505	543	540	490	455	489	450	436	388	422	416	363	315	300	446
60	788	701	743	744	679	635	687	644	606	542	587	595	503	445	438	622
70	1058	953	997	1012	918	867	934	892	825	739	802	827	685	626	624	851
80	1405	1300	1336	1376	1245	1184	1255	1220	1122	1017	1094	1129	933	887	881	1159
90	1919	1828	1854	1925	1744	1674	1698	1686	1570	1444	1543	1551	1294	1308	1260	1492
100	3579	3476	3500	3600	3457	3280	2889	2903	2847	2731	2703	2564	2213	2568	2300	2973

Table 3. Frequencies (and percentage) of vessels landing chinook salmon in British Columbia by gillnets, 1967-1981.

Catch interval (pieces)	Year							
	1967	1968	1969	1970	1971	1972	1973	1974
1-100	2738(76.5)	2884(83.0)	2966(84.7)	2832(8.7)	2772(80.1)	2614(79.7)	2398(83.0)	2522(86.9)
101-200	582(16.3)	433(12.5)	438(12.5)	497(13.8)	482(13.9)	451(13.8)	375(13.0)	278(9.6)
201-300	179(5.0)	103(3.0)	73(2.1)	200(5.6)	136(3.9)	134(4.1)	76(2.6)	62(2.1)
301-400	56(1.6)	35(1.0)	19(0.5)	46(1.3)	37(1.1)	45(1.4)	25(0.9)	31(1.1)
401-500	13(0.4)	16(0.5)	2(0.1)	5(0.1)	5(0.1)	2(0.1)	4(0.1)	1(0.0)
501-600	7(0.2)	2(0.1)	2(0.1)	5(0.1)	5(0.1)	2(0.1)	4(0.1)	1(0.0)
600+	4(0.1)	3(0.1)	1(0.0)	4(0.1)	7(0.2)	8(0.2)	4(0.1)	3(0.1)
Total	3579	3476	3500	3600	3457	3280	2889	2903

Catch interval (pieces)	Year							
	1975	1976	1977	1978	1979	1980	1981	1967-81
1-100	2351(82.6)	2219(81.3)	2106(77.9)	2261(88.2)	1897(85.7)	2268(88.3)	2028(88.2)	2457(82.6)
101-200	365(12.8)	355(13.0)	408(15.1)	223(8.7)	256(11.6)	215(8.4)	179(7.8)	369(12.4)
201-300	91(3.2)	108(4.0)	138(5.1)	61(2.4)	45(2.0)	65(2.5)	65(2.8)	102(3.4)
301-400	28(1.0)	24(0.9)	35(1.3)	12(0.5)	11(0.5)	16(0.6)	21(0.9)	29(1.0)
401-500	7(0.2)	12(0.4)	9(0.3)	5(0.2)	2(0.1)	3(0.1)	3(0.1)	10(0.3)
501-600	1(0.0)	9(0.3)	3(0.1)	1(0.0)	1(0.0)	0(0.0)	2(0.1)	3(0.1)
600+	4(0.1)	4(0.1)	4(0.1)	1(0.0)	1(0.0)	0(0.0)	2(0.1)	3(0.1)
Total	2847	2731	2703	2564	2213	2568	2300	2973

Table 4. Percentage of the total landings of chinook salmon that the top 50% of the vessels participating in the fishery account for in each gear type.

Year	Gillnet	Seine	Troll
1967	88	84	94
1968	89	86	96
1969	88	81	92
1970	88	89	93
1971	90	90	93
1972	89	88	94
1973	85	82	92
1974	85	82	91
1975	87	82	91
1976	88	81	90
1977	86	78	89
1978	84	77	89
1979	85	78	88
1980	90	77	89
1981	88	80	91
Mean	87	82	91

Table 5. A measure of the repeatability of success of landing chinook salmon by gillnetters. The top 200 trollers in terms of chinook salmon landings were identified each year (diagonal in table). The number of times that those 200 vessels were in the top 200 in previous and subsequent years is recorded by column. For example, of the top 200 gillnetters in 1975, 43 of those 200 were in the top 200 in 1971, and 64 in the top 200 in 1979. Twenty or more vessels in each year is indicative of a significant statistical association.

Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1967	200	71	56	58	45	49	42	29	21	30	17	22	13	13	6
1968	71	200	63	49	45	43	47	29	27	23	16	17	14	4	5
1969	56	63	200	86	91	77	71	48	36	34	33	30	23	16	15
1970	58	49	86	200	97	87	69	47	35	43	37	33	29	22	18
1971	45	45	91	97	200	101	82	57	43	44	36	34	40	19	16
1972	49	43	77	87	101	200	107	71	62	64	45	44	42	25	20
1973	42	47	71	69	82	107	200	89	68	65	53	49	41	23	16
1974	29	29	48	47	57	71	89	200	86	87	62	60	53	29	22
1975	21	27	36	35	43	62	68	86	200	99	75	70	64	30	27
1976	30	23	34	43	44	64	65	87	99	200	96	84	69	45	32
1977	17	16	33	37	36	45	53	62	75	96	200	84	73	39	38
1978	22	17	30	33	34	44	49	60	70	84	84	200	89	47	33
1979	13	14	23	29	40	42	41	53	64	69	73	89	200	49	54
1980	13	4	16	22	19	25	23	29	30	45	39	47	49	200	87
1981	6	5	15	18	16	20	16	22	27	32	38	33	54	87	200

Table 6. Number of purse seiners accounting for varying percentages of the total seine landings of chinook salmon in British Columbia, 1967-1981.

Percent of total landings	Year															
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1967-81
10	6	7	11	8	5	9	8	7	8	12	11	14	8	14	11	9
20	20	21	26	18	15	20	23	23	24	29	28	34	22	34	26	24
30	40	39	44	31	29	36	42	43	44	50	50	59	44	60	48	44
40	63	60	65	47	46	55	66	67	69	74	76	89	73	92	76	62
50	89	86	91	68	68	76	92	95	98	104	110	122	109	129	110	83
60	122	117	120	94	95	103	123	129	134	139	150	163	151	173	152	131
70	162	152	156	130	127	138	162	171	178	184	198	211	202	225	201	173
80	211	195	200	180	171	185	209	228	233	239	256	269	268	290	265	227
90	279	252	256	252	230	249	269	307	304	316	334	347	353	375	356	299
100	476	456	412	492	461	463	447	485	487	484	489	495	515	532	532	481

Table 7. Frequencies (and percentage) of vessels landing chinook salmon in British Columbia by purse seines 1967-1981.

Catch interval (pieces)	Year							
	1967	1968	1969	1970	1971	1972	1973	1974
0-200	355(74.6)	355(7.9)	272(66.0)	289(58.7)	278(60.3)	265(57.2)	175(39.1)	249(51.3)
201-400	98(20.6)	83(18.2)	108(26.2)	99(20.1)	99(21.5)	108(23.3)	137(30.6)	123(25.4)
401-600	15(3.2)	14(3.1)	25(6.1)	34(6.9)	45(9.8)	47(10.2)	68(15.2)	65(13.4)
601-800	3(0.6)	1(0.2)	5(1.2)	31(6.3)	16(3.5)	22(4.8)	37(8.3)	30(6.2)
801-1000	1(0.2)	0(0.0)	2(0.5)	11(2.2)	11(2.4)	7(1.5)	16(3.6)	10(2.1)
1001-1200	0(0.0	0(0.0)	0(0.0)	7(1.4)	6(1.3)	5(1.1)	5(1.1)	4(0.8)
1201-1400	3(0.6)	2(0.4)	0(0.0)	7(1.4)	1(0.2)	8(1.7)	2(0.4)	0(0.0)
1400+	1(0.2)	1(0.2)	0(0.0)	14(2.8)	5(1.1)	1(0.2)	7(1.6)	4(0.8)
Total	476	456	412	492	461	463	447	485

Catch interval (pieces)	Year							
	1975	1976	1977	1978	1979	1980	1981	1967-81
0-200	219(45.0)	250(51.7)	144(29.4)	140(28.3)	185(35.9)	271(50.9)	264(49.6)	248(51.6)
201-400	154(31.6)	127(26.2)	168(34.4)	179(36.2)	185(35.9)	177(33.3)	152(28.6)	133(27.7)
401-600	69(14.2)	61(12.6)	84(17.2)	90(18.2)	82(15.9)	53(10.0)	61(11.5)	54(11.2)
601-800	19(3.9)	30(6.2)	42(8.6)	47(9.5)	28(5.4)	21(3.9)	26(4.9)	24(5.0)
801-1000	7(1.4)	8(1.7)	24(4.9)	24(4.8)	14(2.7)	5(0.9)	11(2.1)	10(2.1)
1001-1200	3(0.6)	5(1.0)	12(2.5)	4(0.8)	3(0.6)	2(0.4)	9(1.7)	4(0.8)
1201-1400	0(0.0)	3(0.6)	7(1.4)	5(1.0)	5(1.0)	1(0.2)	3(0.6)	3(0.6)
1400+	6(1.2)	0(0.0)	8(1.6)	6(1.2)	13(2.5)	2(0.4)	6(1.1)	5(1.0)
Total	487	484	489	495	515	532	532	481

Table 8. A measure of the repeatability of success of landing chinook salmon by purse seiners. The top 100 seiners in terms of weight of salmon landings were identified each year (diagonal in table). The number of times that those 100 vessels were in the top 100 in previous and subsequent years is recorded by column. For example, of the top 100 seiners in 1975, 26 of those 100 were also in the top 100 in 1969 and 30 in vessels in 1981. Thirty or more vessels is indicative of a significant statistical association.

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1969	100	39	54	49	36	32	25	23	21	20	16	9	14
1970	39	100	35	37	31	28	21	23	19	18	11	11	11
1971	54	35	100	50	38	32	23	24	20	18	17	8	19
1972	49	37	50	100	44	39	27	27	19	26	14	17	15
1973	36	31	38	44	100	47	35	29	27	28	17	14	13
1974	32	28	32	39	47	100	29	37	29	23	13	20	13
1975	25	21	23	27	35	29	100	29	31	30	26	16	19
1976	23	23	24	27	29	37	29	100	42	30	21	21	20
1977	21	19	20	19	27	29	31	42	100	41	32	23	21
1978	20	18	18	26	28	23	30	30	41	100	35	23	19
1979	16	11	17	14	17	13	26	21	32	35	100	32	37
1980	9	11	8	17	14	20	16	21	23	23	32	100	37
1981	14	11	19	15	13	13	19	20	21	19	37	37	100

Table 9. Number of trollers accounting for varying percentages of the total troll-caught landings of salmon in British Columbia, 1967-1981.

Percent of total landings	Year															
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1967-81
10	38	18	47	49	55	52	42	46	53	53	51	57	59	67	43	49
20	108	49	115	125	133	127	107	116	128	126	126	138	141	162	111	121
30	203	88	204	222	224	220	189	203	218	213	221	238	242	278	197	211
40	322	135	311	340	333	332	288	305	325	317	337	359	361	415	304	319
50	465	192	444	483	463	462	407	425	449	443	475	504	503	579	436	449
60	639	263	606	662	621	620	553	569	598	597	636	674	670	775	597	605
70	851	366	810	888	822	815	737	745	780	788	834	880	875	1015	795	800
80	1130	558	1081	1178	1095	1073	984	973	1007	1034	1095	1142	1144	1321	1049	1058
90	1544	909	1486	1599	1501	1455	1347	1304	1344	1383	1466	1519	1540	1765	1428	1439
100	3643	2799	3236	3470	3463	3340	2836	2692	2782	2736	2796	2928	2922	3428	2900	3065

Table 10. Frequencies (and percentage) of vessels landing chinook salmon in British Columbia by troll gear, 1967-1981.

Catch interval (pieces)	Year							
	1967	1968	1969	1970	1971	1972	1973	1974
0-200	2379(65.3)	1860(66.5)	1984(61.3)	2168(62.5)	1846(53.3)	1749(52.4)	1377(48.6)	1210(44.9)
201-400	614(16.9)	357(12.8)	571(17.6)	684(19.7)	538(15.5)	532(15.9)	556(19.6)	441(16.4)
401-600	345(9.5)	145(5.2)	308(9.5)	290(8.4)	319(9.2)	315(9.4)	280(9.9)	302(11.2)
601-800	147(4.0)	70(2.5)	151(4.7)	163(4.7)	219(6.3)	240(7.2)	202(7.1)	223(8.3)
801-1000	64(1.8)	39(1.4)	104(3.2)	75(2.2)	166(4.8)	164(4.9)	139(4.9)	167(6.2)
1001-1200	42(1.2)	36(1.3)	51(1.6)	46(1.3)	115(3.3)	126(3.8)	102(3.6)	134(5.0)
1201-1400	13(0.4)	44(1.6)	24(0.7)	18(0.5)	89(2.6)	79(2.4)	58(2.0)	77(2.9)
1401-1600	13(0.4)	25(0.9)	23(0.7)	9(0.3)	80(2.3)	46(1.4)	45(1.6)	51(1.9)
1600+	26(0.7)	223(8.0)	20(0.6)	17(0.5)	91(2.6)	89(2.7)	77(2.7)	87(3.2)
Total	3643	2799	3236	3470	3463	3340	2836	2692

Catch interval (pieces)	Year							
	1975	1976	1977	1978	1979	1980	1981	1967-81
0-200	1318(47.4)	1147(41.9)	1250(44.7)	1350(46.1)	1397(47.8)	1758(51.3)	1568(54.1)	1624(53.0)
201-400	431(15.5)	470(17.2)	540(19.3)	584(19.9)	591(20.2)	701(20.4)	559(19.3)	545(17.8)
401-600	347(12.5)	360(13.2)	351(12.6)	401(13.7)	357(12.2)	446(13.0)	346(11.9)	327(10.7)
601-800	228(8.2)	245(9.0)	266(9.5)	260(8.9)	248(8.5)	233(6.8)	172(5.9)	204(6.7)
801-1000	169(6.1)	148(5.4)	161(5.8)	129(4.4)	149(5.1)	144(4.2)	105(3.6)	128(4.2)
1001-1200	115(4.1)	108(3.9)	81(2.9)	90(3.1)	83(2.8)	78(2.3)	60(2.1)	85(2.8)
1201-1400	71(2.6)	88(3.2)	55(2.0)	43(1.5)	40(1.4)	32(0.9)	37(1.3)	52(1.7)
1401-1600	42(1.5)	57(2.1)	32(1.1)	29(1.0)	29(1.0)	16(0.5)	19(0.7)	34(1.1)
1600+	61(2.2)	113(4.1)	60(2.1)	42(1.4)	28(1.0)	20(0.6)	34(1.2)	66(2.2)
Total	2782	2736	2796	2988	2922	3428	2900	3065

Table 11. A measure of the repeatability of success of landing chinook salmon by trollers. The top 200 trollers in terms of weight of salmon landings were identified each year (diagonal in table). The number of times that those 200 vessels were in the top 200 in previous and subsequent years is recorded by column. For example, of the top 200 trollers in 1975, 131 of those 200 were also in the top 200 trollers in 1967 and 162 in the top 200 in 1981. Twenty or more vessels is indicative of a significant statistical association.

Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1967	200	24	90	71	63	60	51	53	48	40	38	29	27	20	15
1968	24	200	15	16	12	14	11	12	10	13	9	13	10	6	3
1969	90	15	200	111	93	87	79	70	66	59	49	38	38	28	20
1970	71	16	111	200	100	83	84	78	68	63	57	41	34	29	22
1971	63	12	93	100	200	100	98	85	70	69	63	60	48	34	25
1972	60	14	87	83	100	200	115	89	79	76	63	58	45	34	26
1973	51	11	79	84	98	115	200	106	94	76	77	64	52	37	23
1974	53	12	70	78	85	89	106	200	111	89	86	68	58	42	30
1975	48	10	66	68	70	79	94	111	200	89	91	70	58	45	36
1976	40	13	59	63	69	76	76	89	89	200	102	80	66	54	41
1977	38	9	49	57	63	63	77	86	91	102	200	102	80	58	47
1978	29	13	38	41	60	58	64	68	70	80	102	200	93	67	50
1979	27	10	38	34	48	45	52	58	58	66	80	93	200	95	69
1980	20	6	28	29	34	34	37	42	45	54	58	67	95	200	91
1981	15	3	20	22	25	26	23	30	36	41	47	50	69	91	200

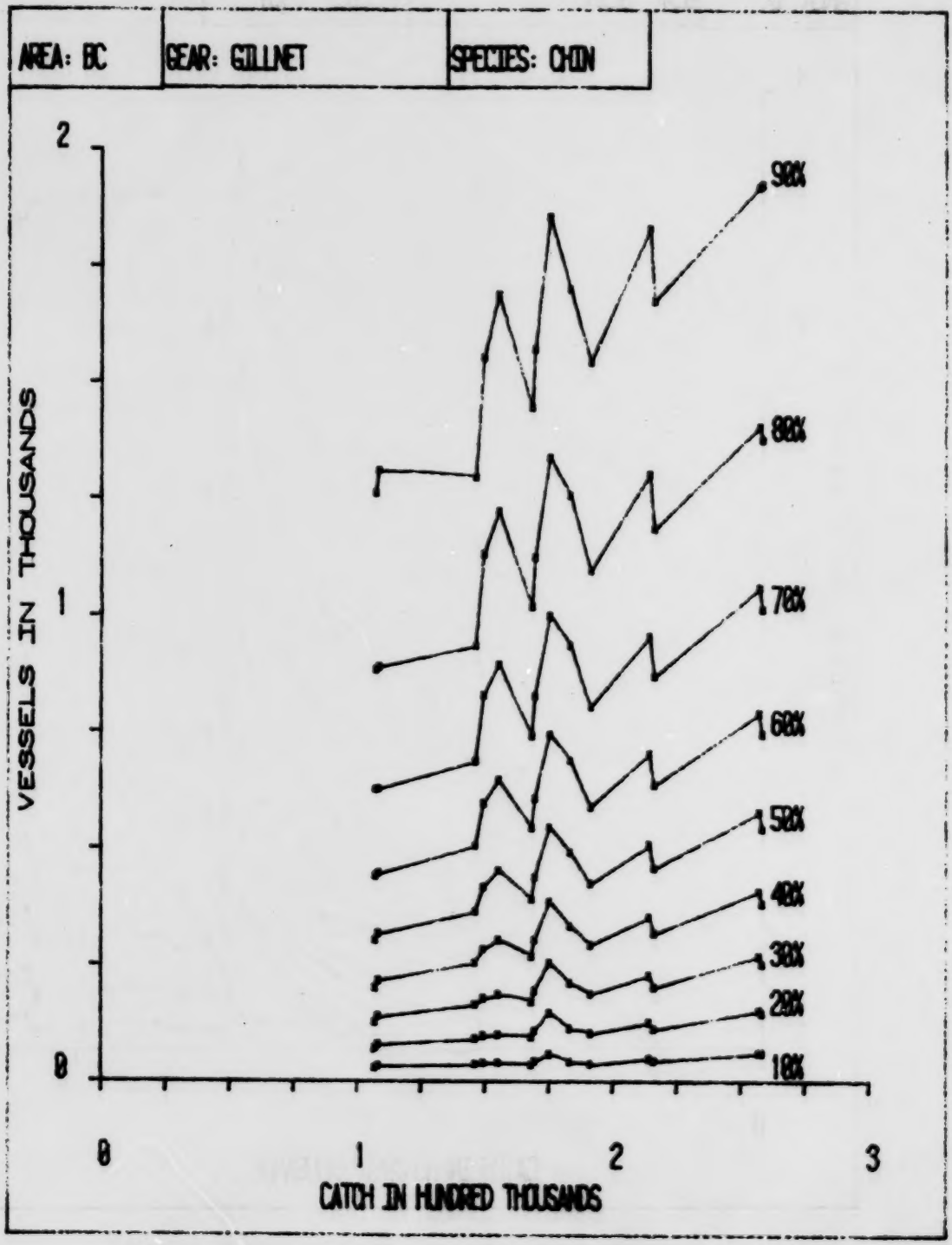

Figure 1. Contour plots for the number of gillnetters that harvesed a fixed percentage of the total annual catch of chinook salmon by gillnetters versus the size of the annual catch during 1967-1981.

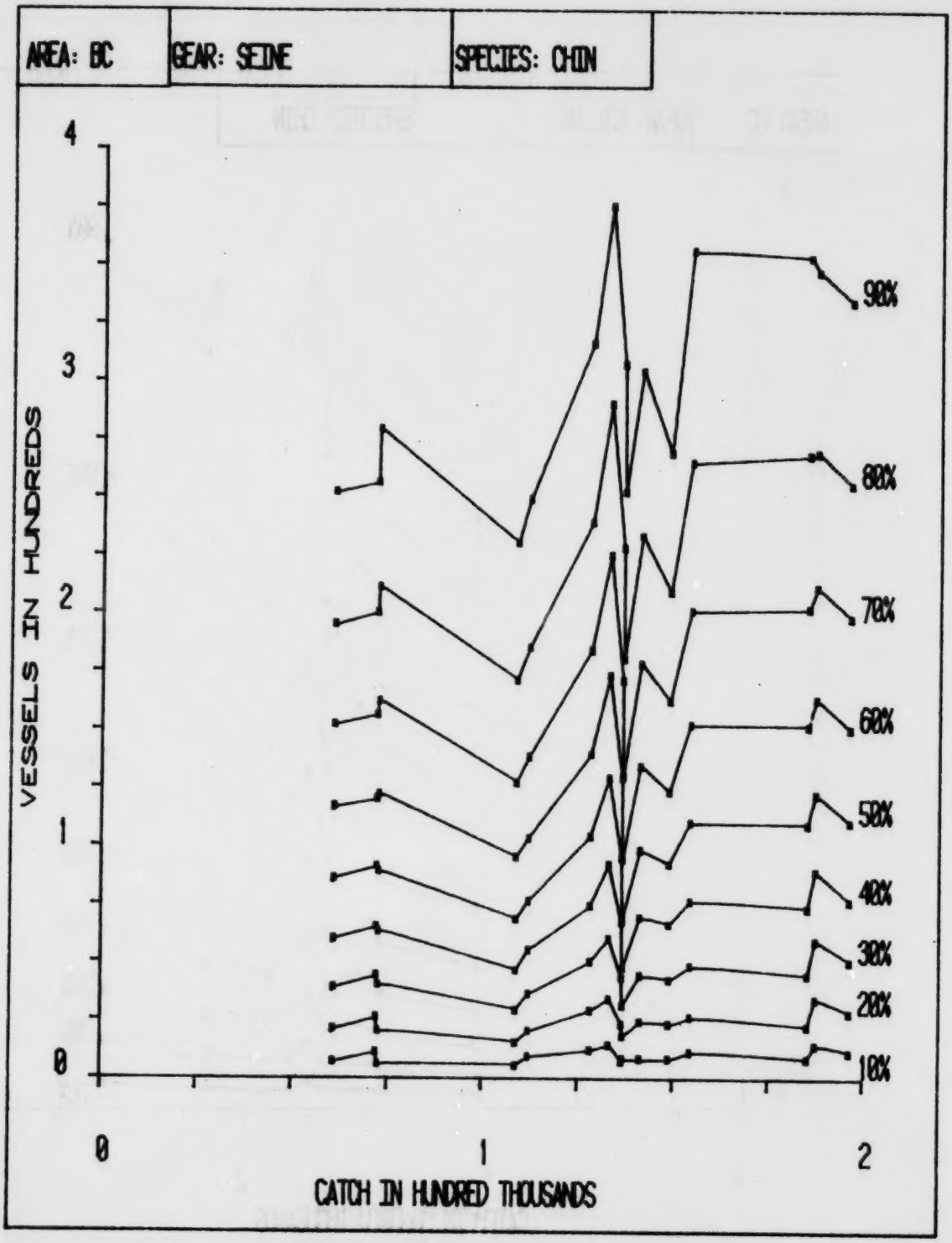

Figure 2. Contour plots for the number of seiners that harvested a fixed percentage of the total annual catch of chinook salmon by seiners versus the size of the annual catch during 1967-1981.

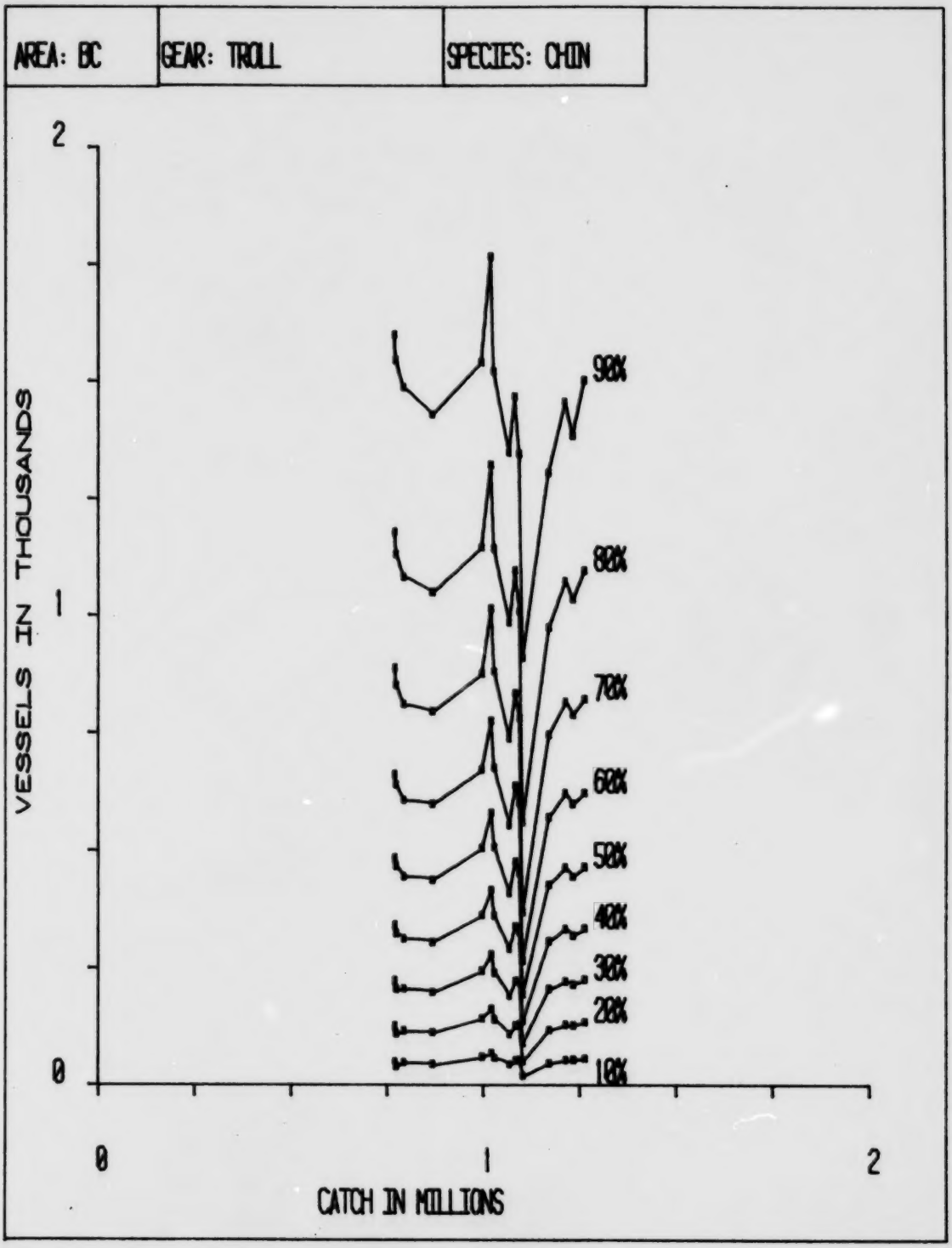

Figure 3. Contour plots for the number of trollers that harvested a fixed percentage of the total annual catch of chinook salmon by trollers versus the size of the annual catch during 1967-1981.

APPENDIX A

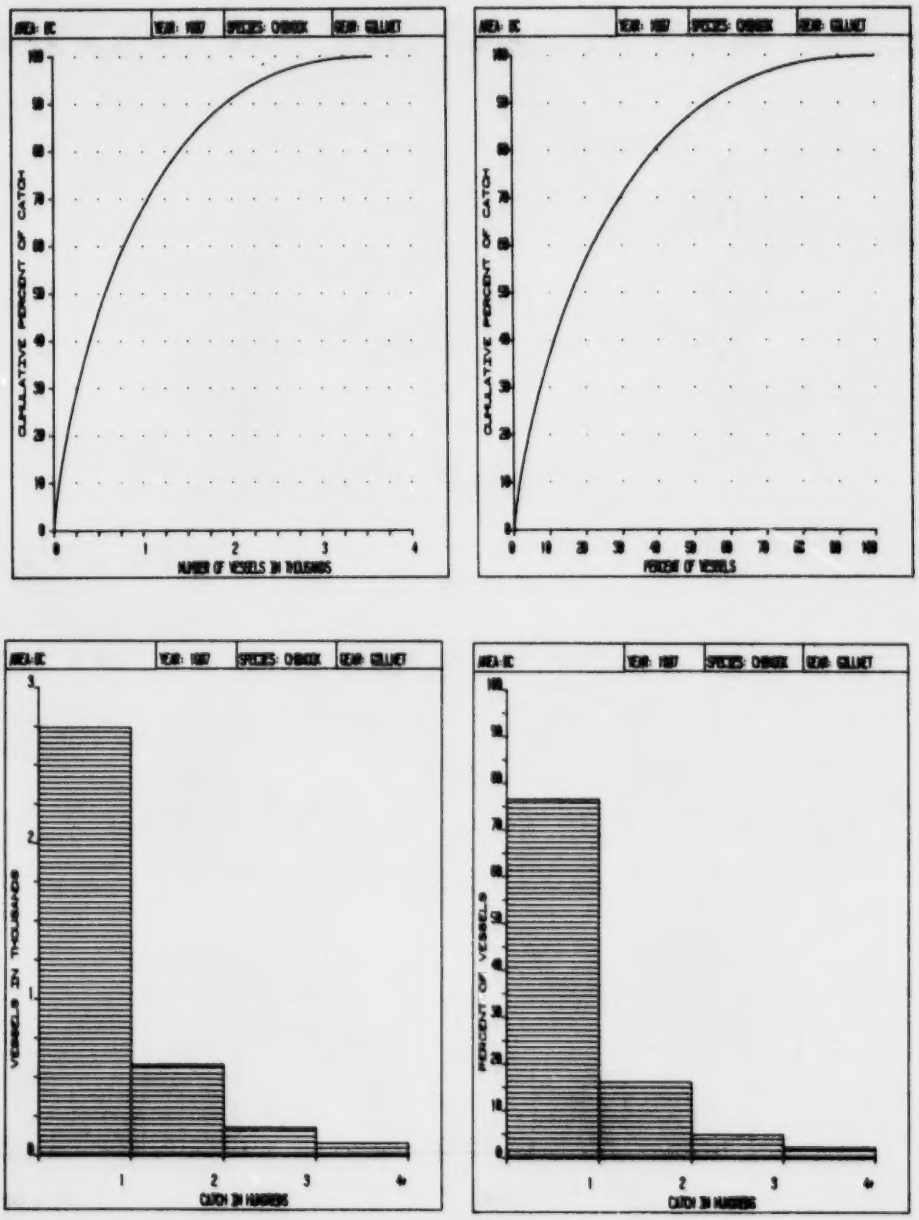

Figure A1. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1967.

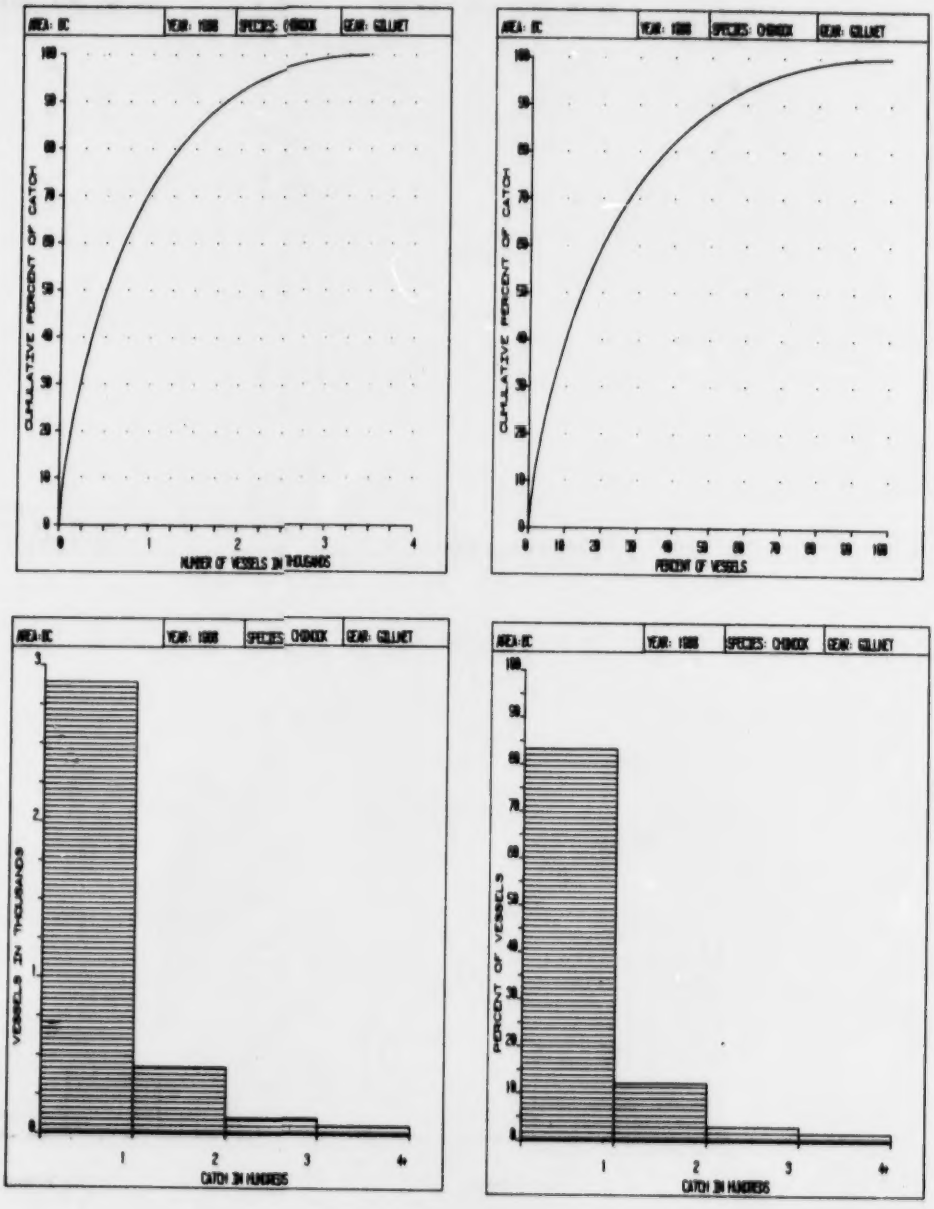

Figure A2. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1968.

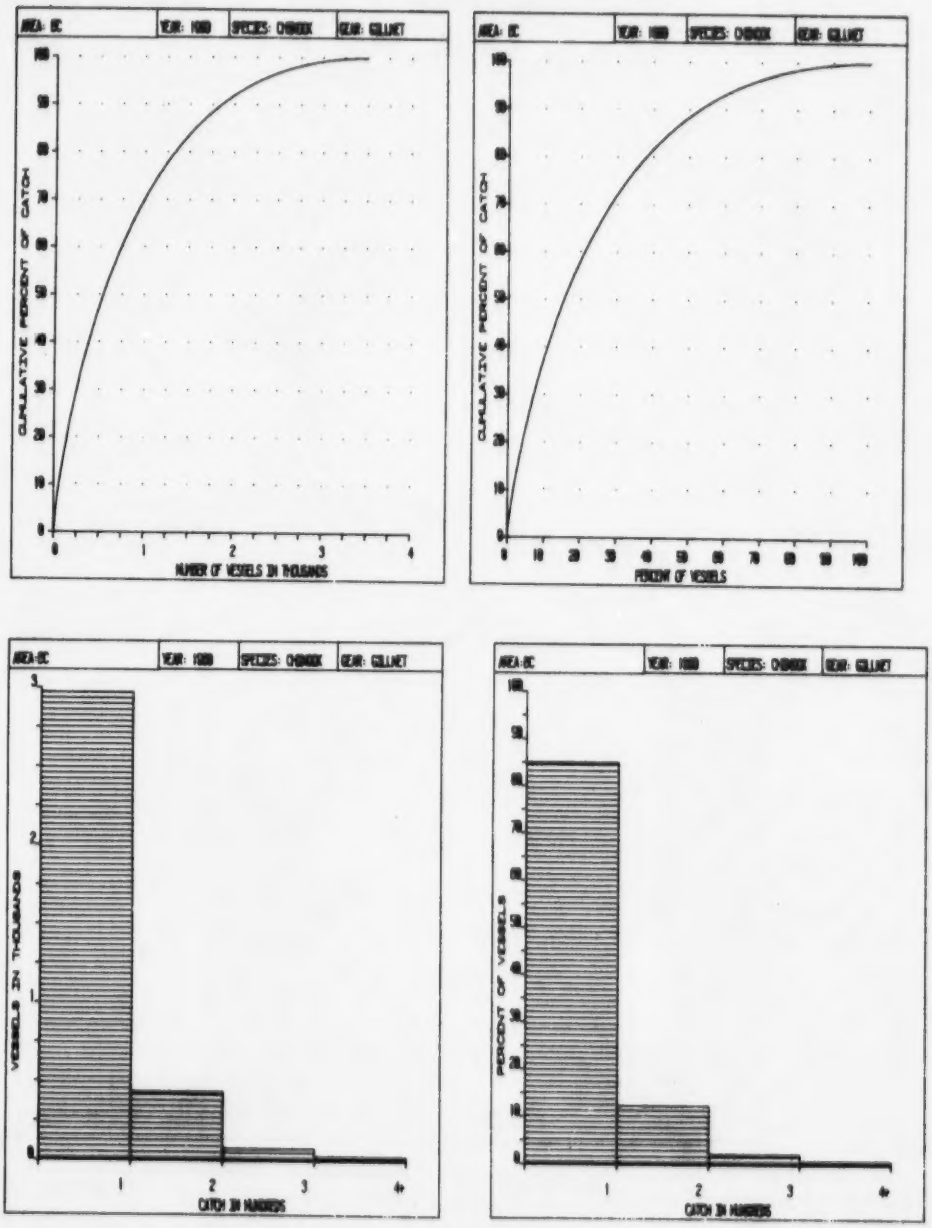

Figure A3. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1969.

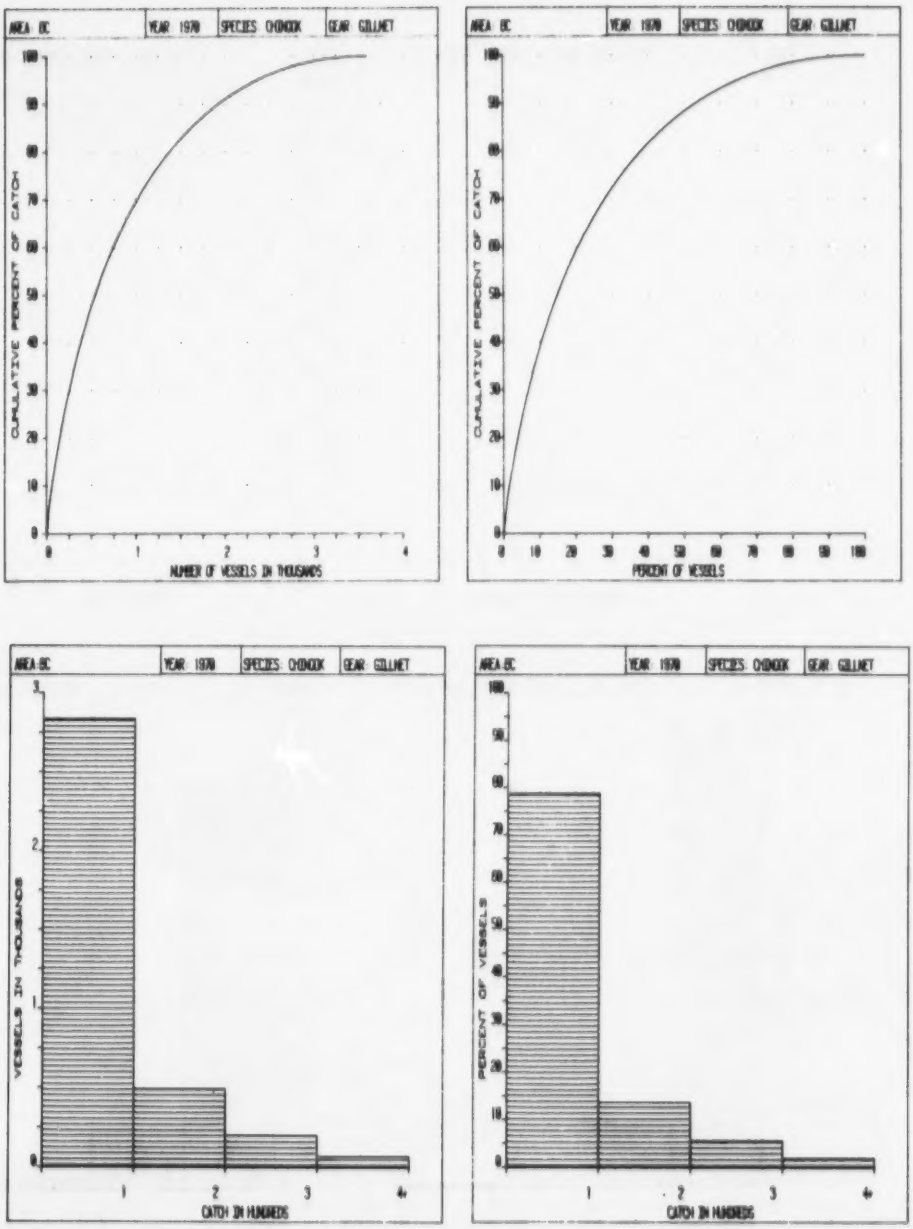

Figure A4. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1970

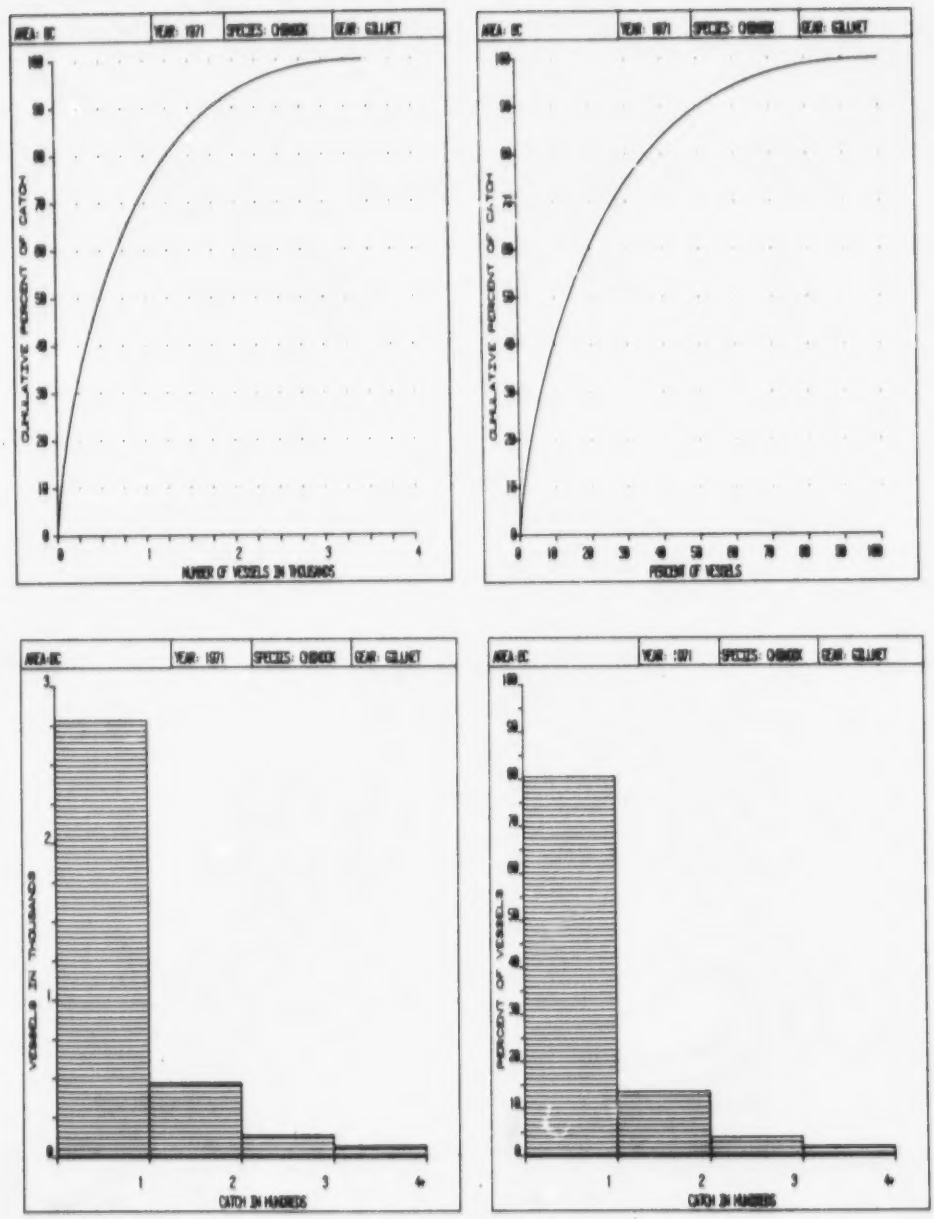

Figure A5. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1971.

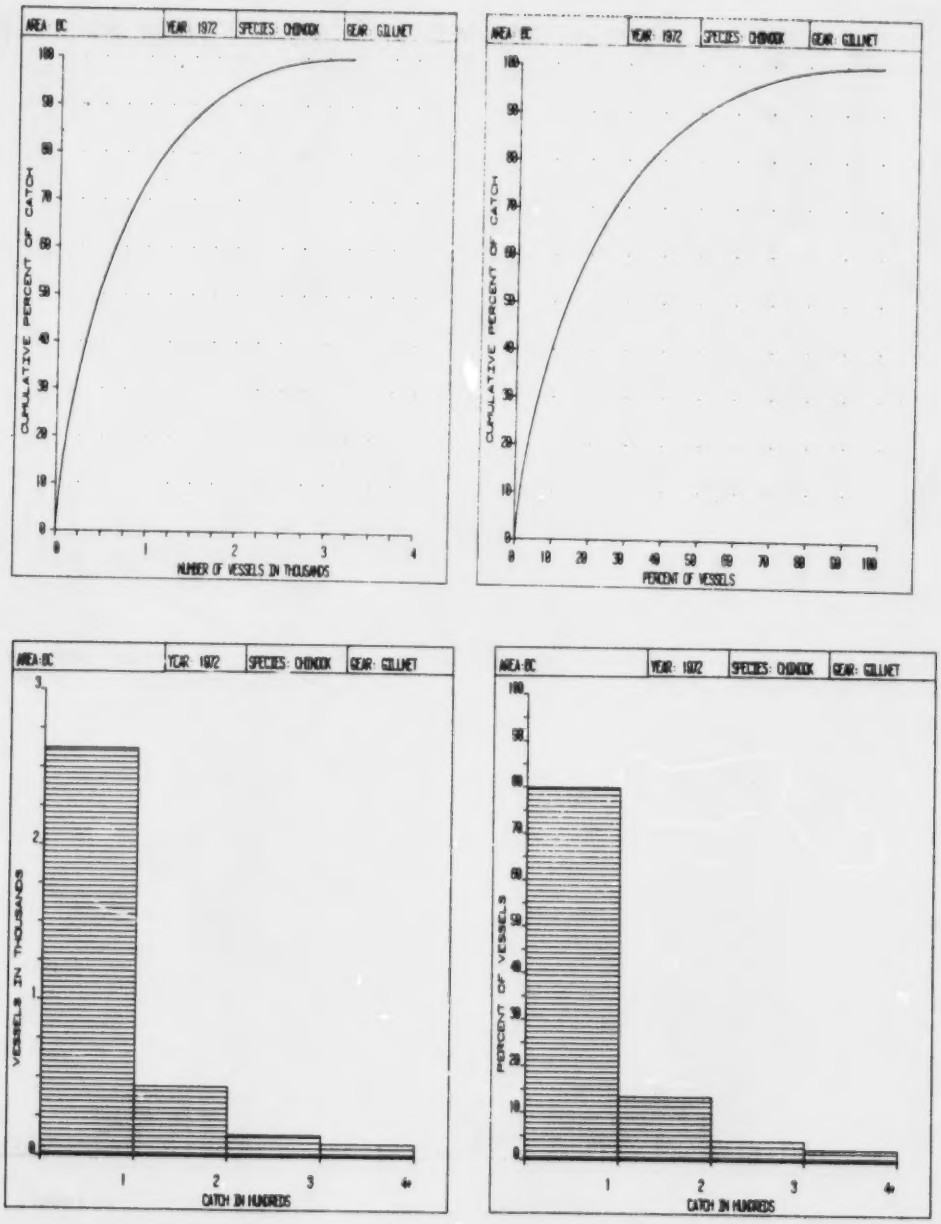

Figure A6. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1972.

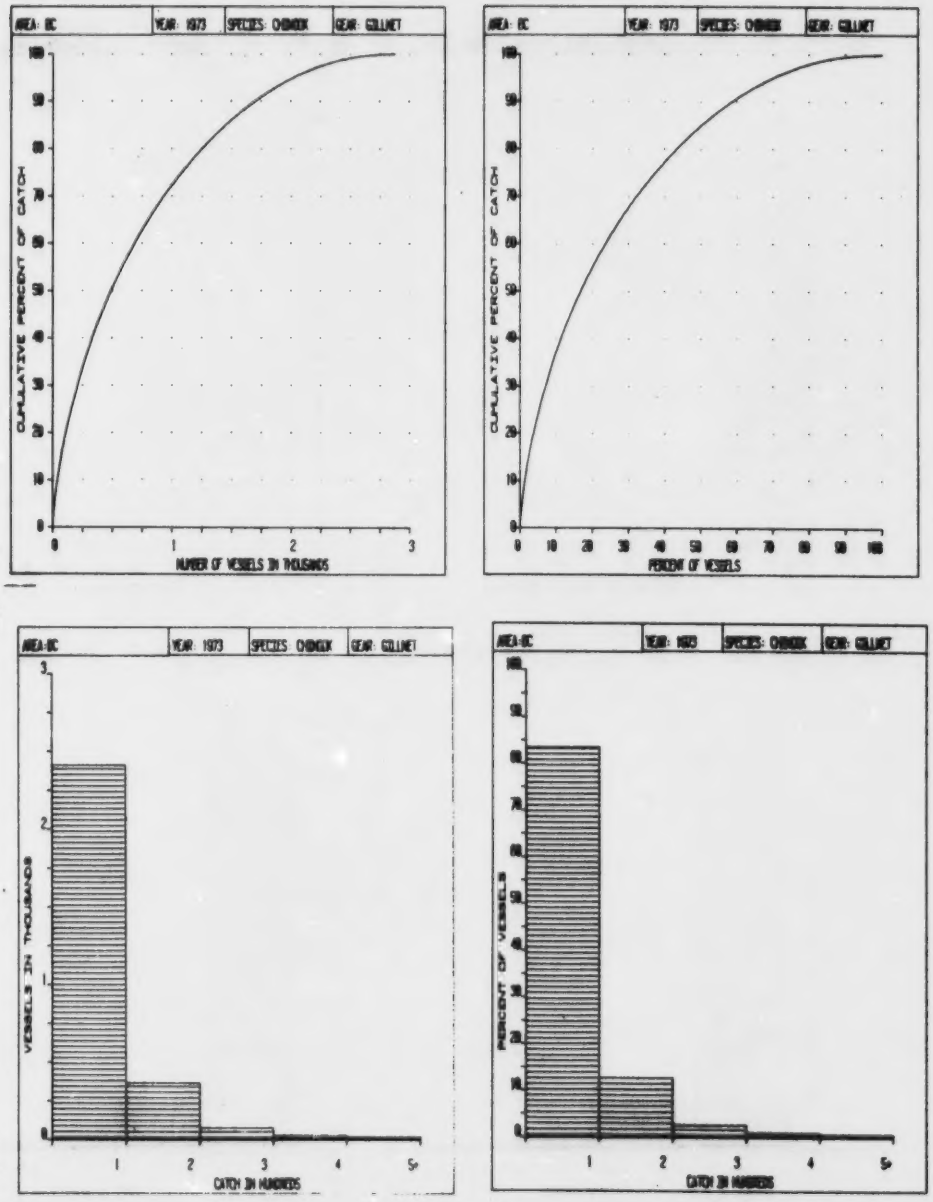

Figure A7. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1973.

Figure A8. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1974.

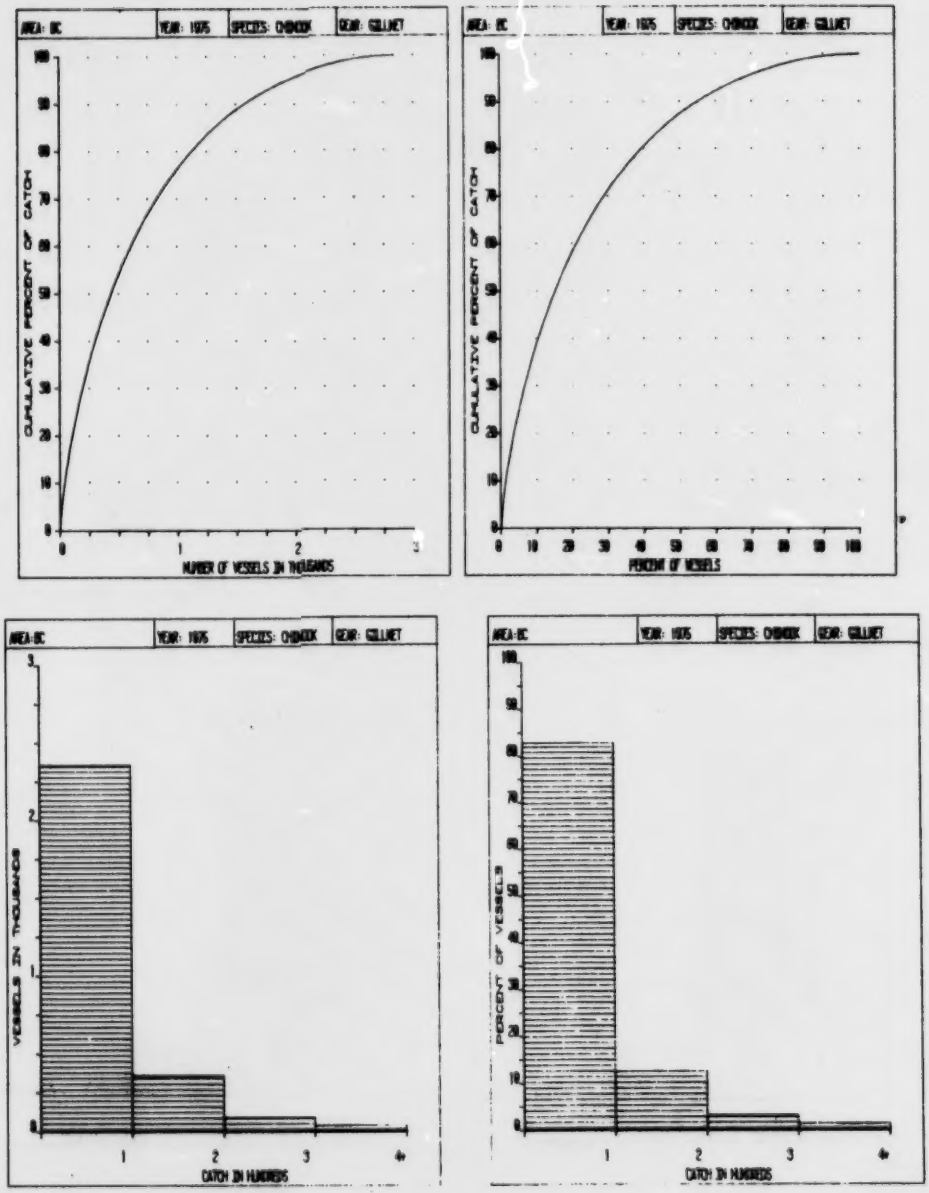

Figure A9. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1975.

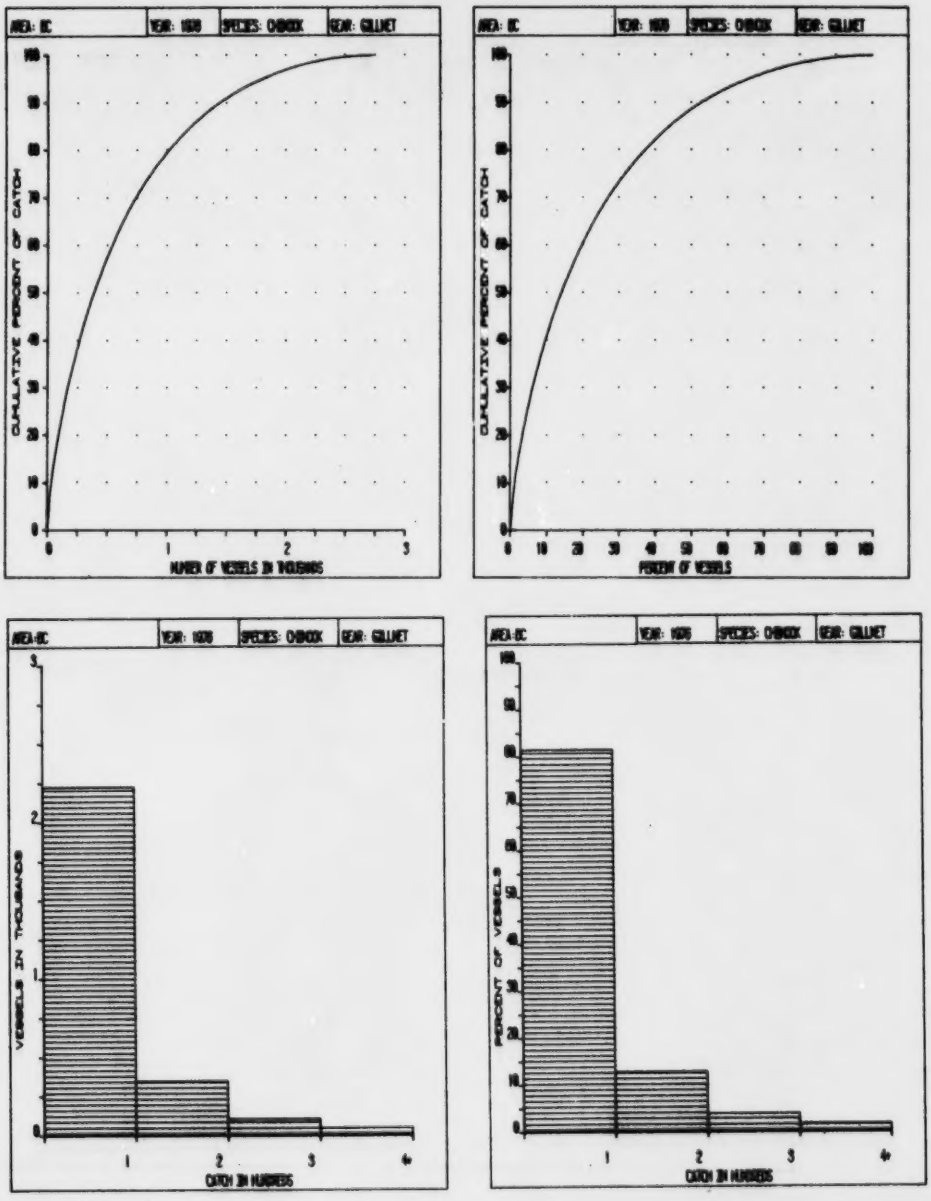

Figure A10. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1976.

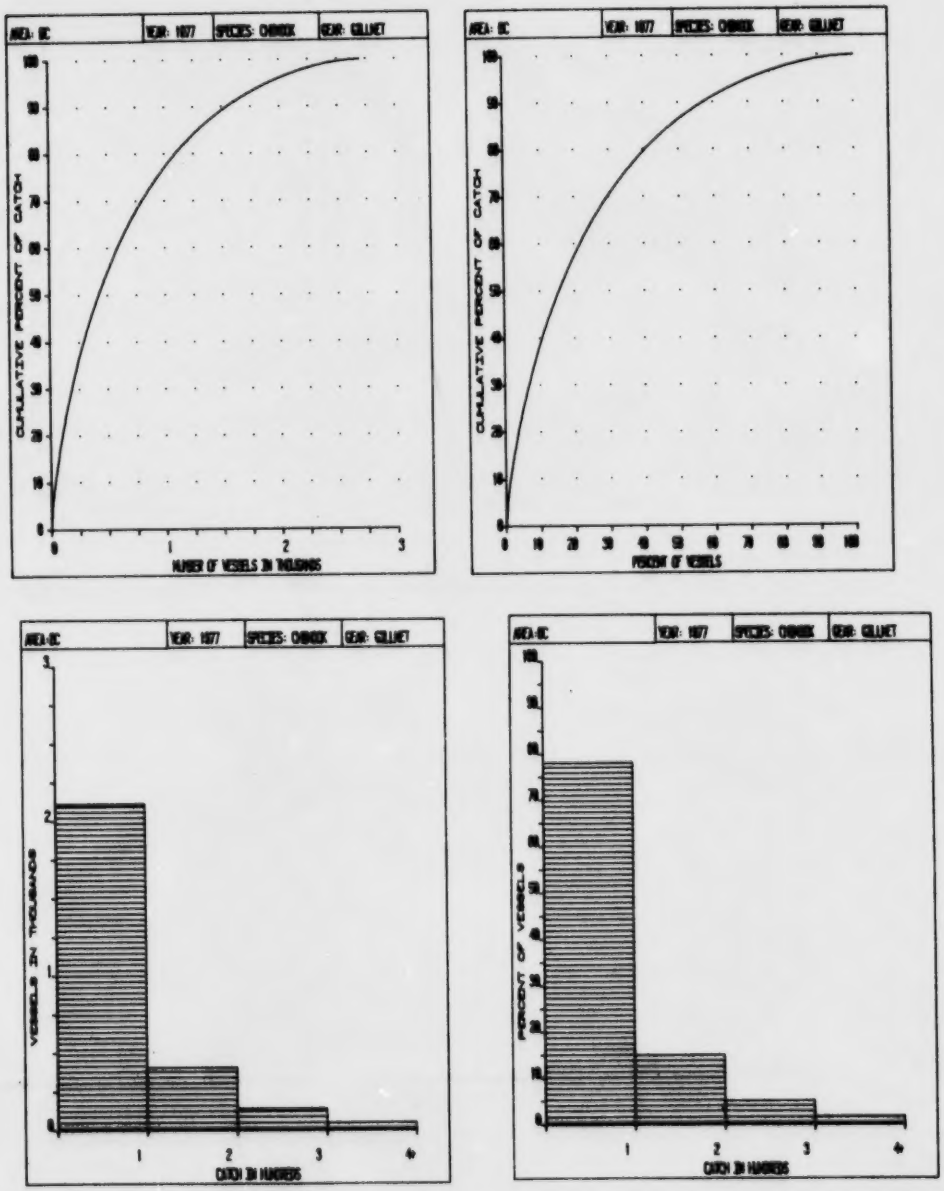

Figure A11. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1977.

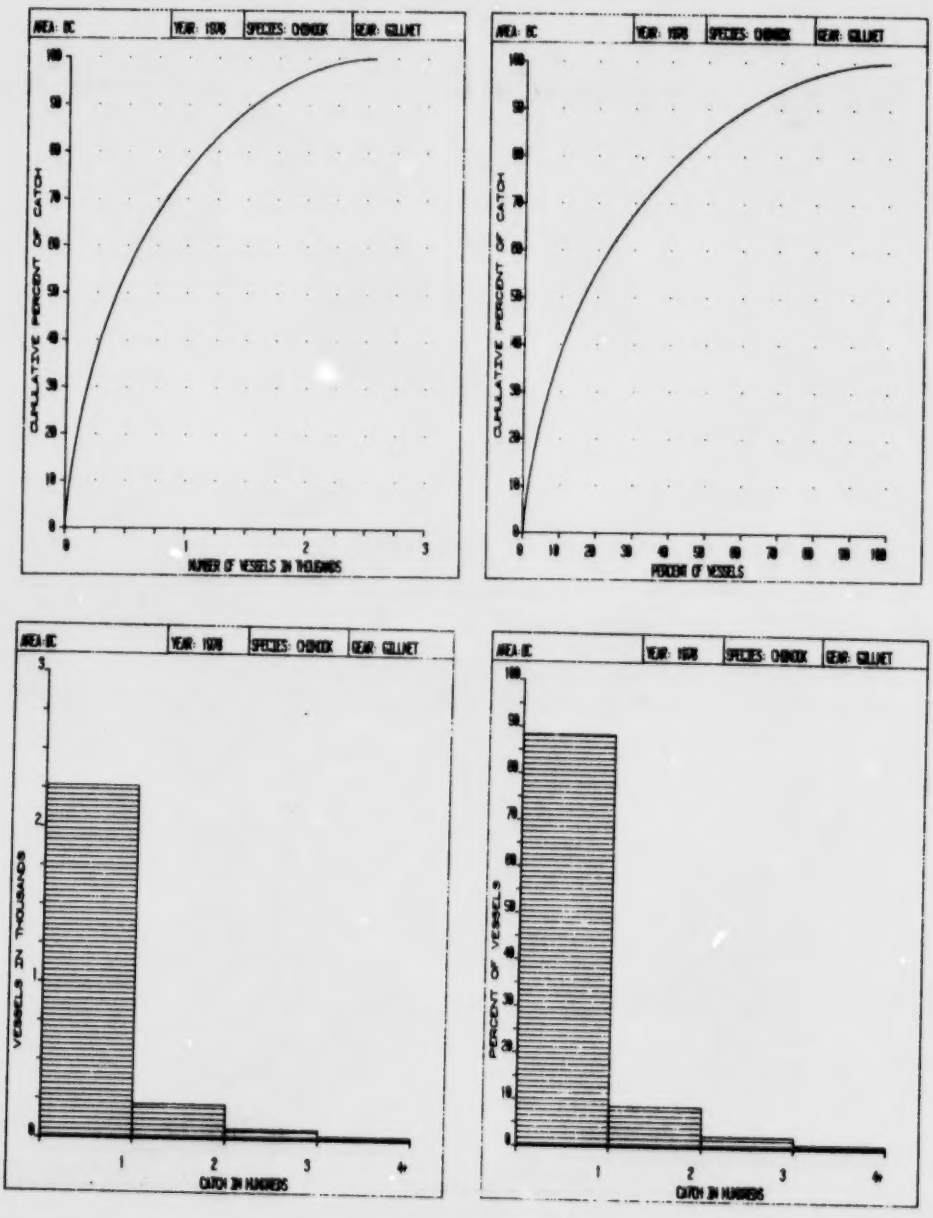

Figure A12. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1978.

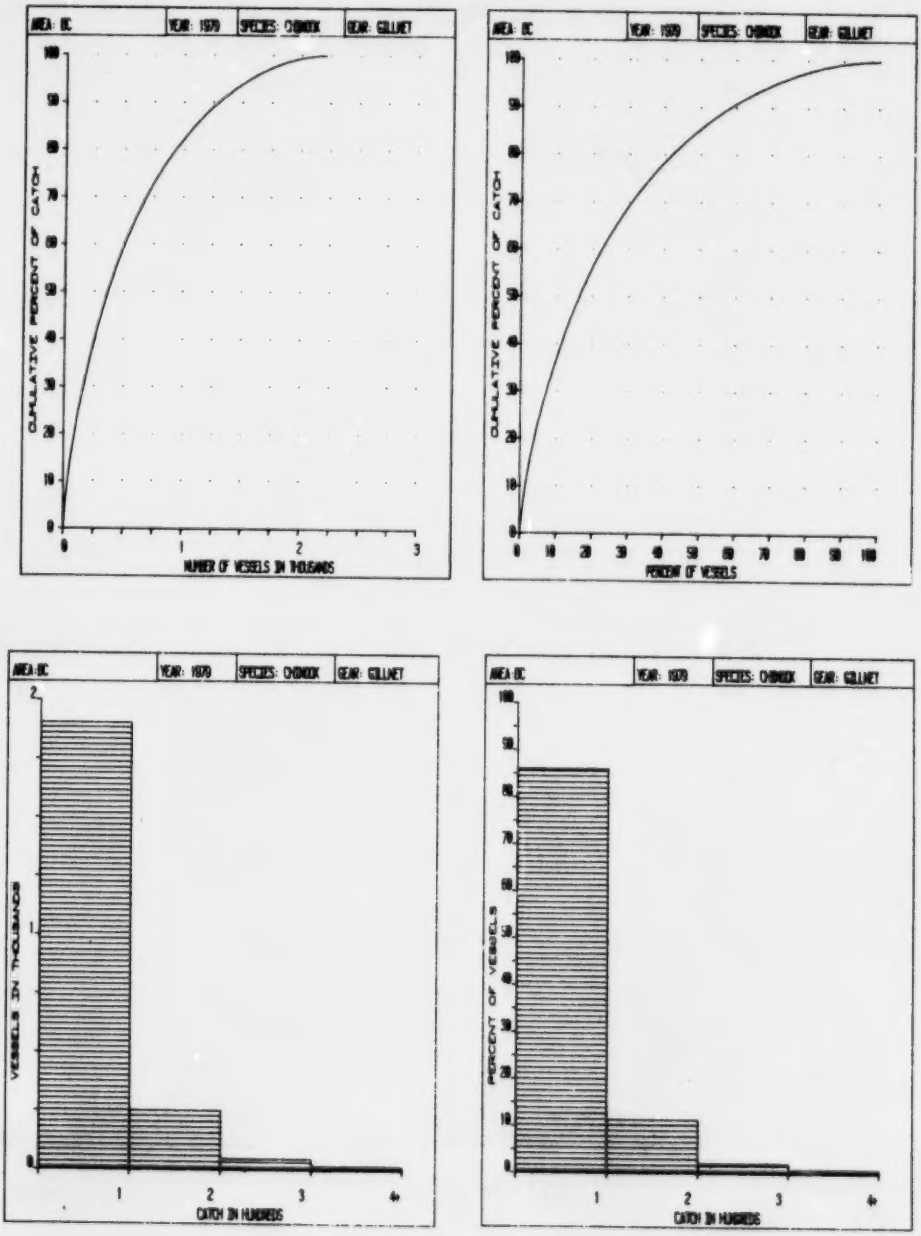

Figure A13. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1979.

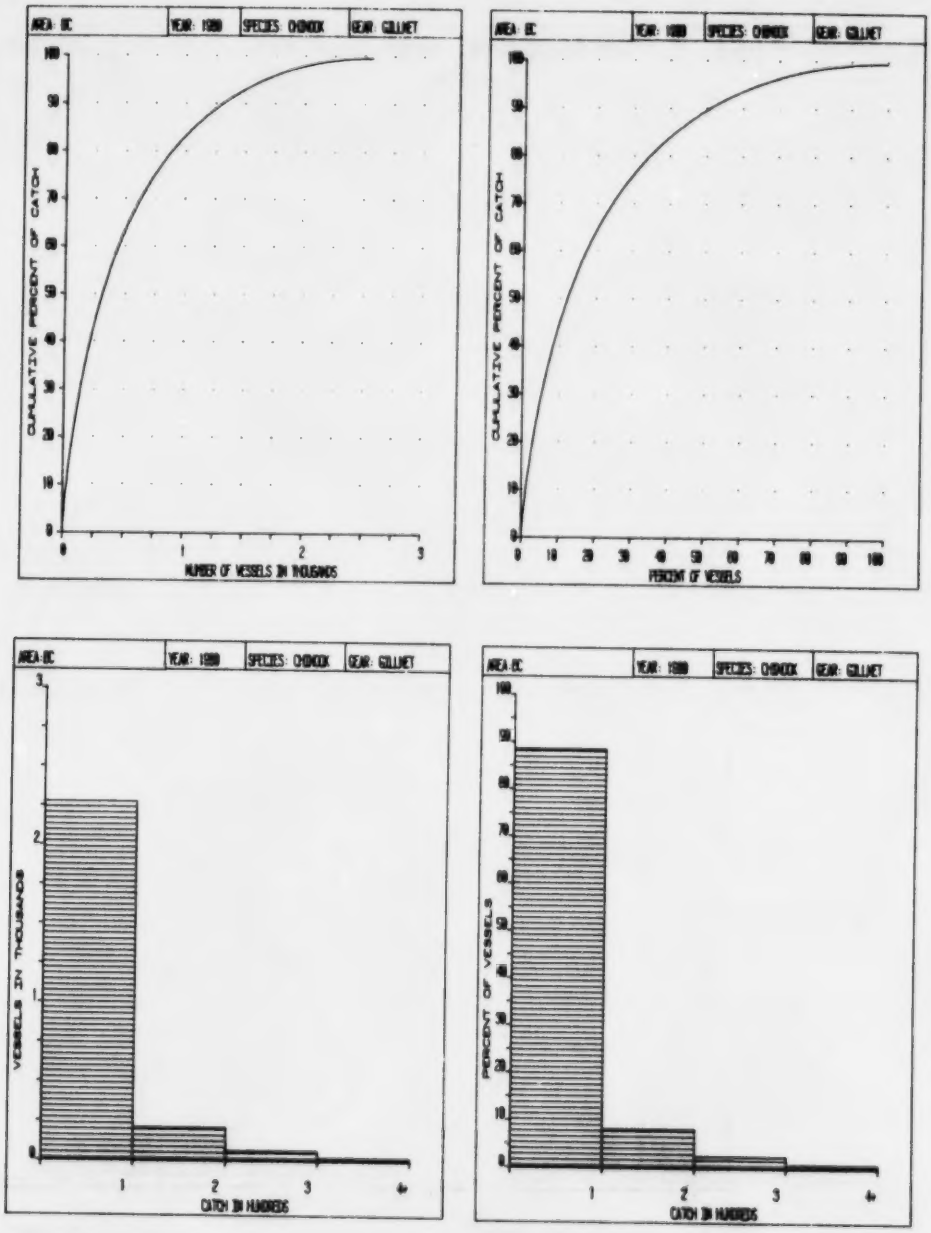

Figure A14. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1980.

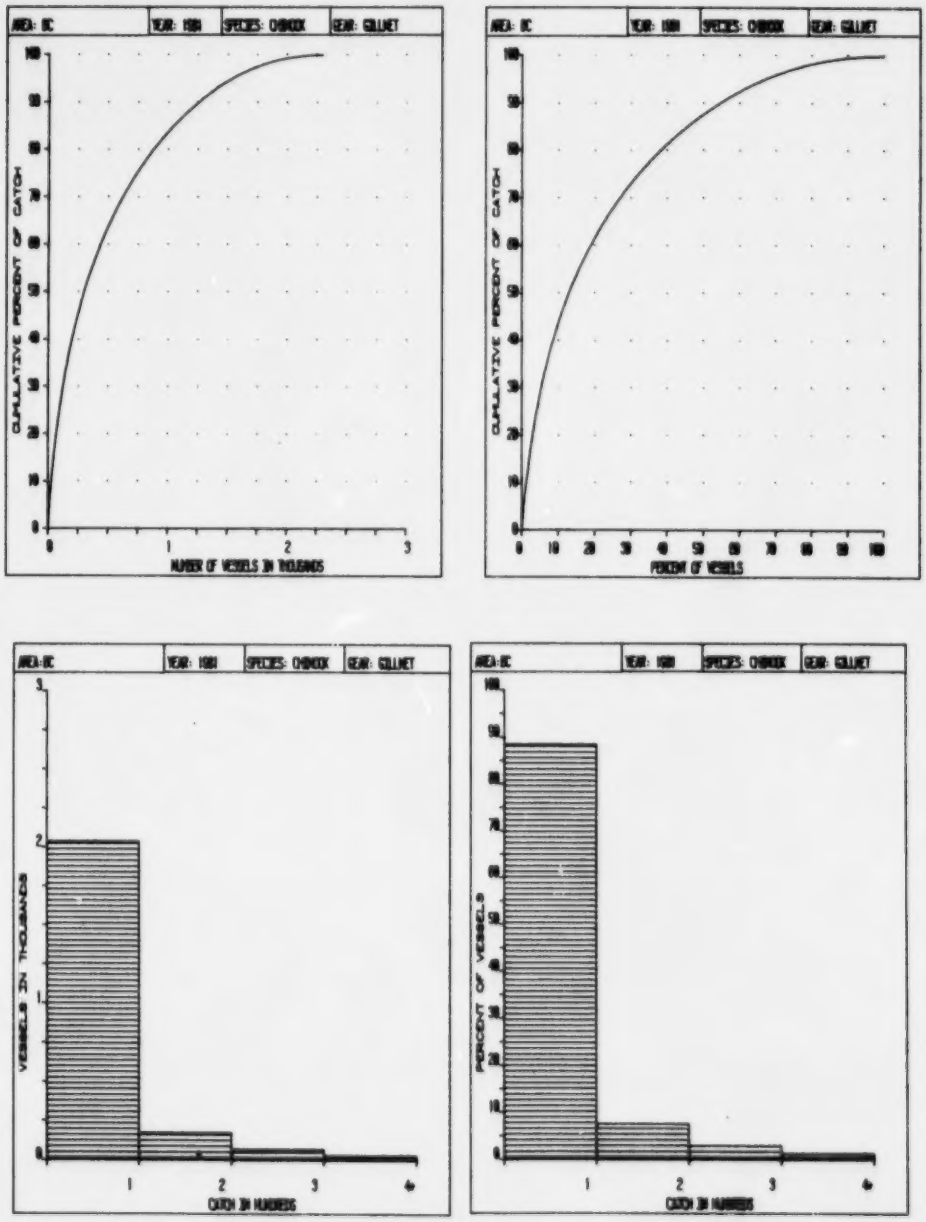

Figure A15. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1981.

APPENDIX B

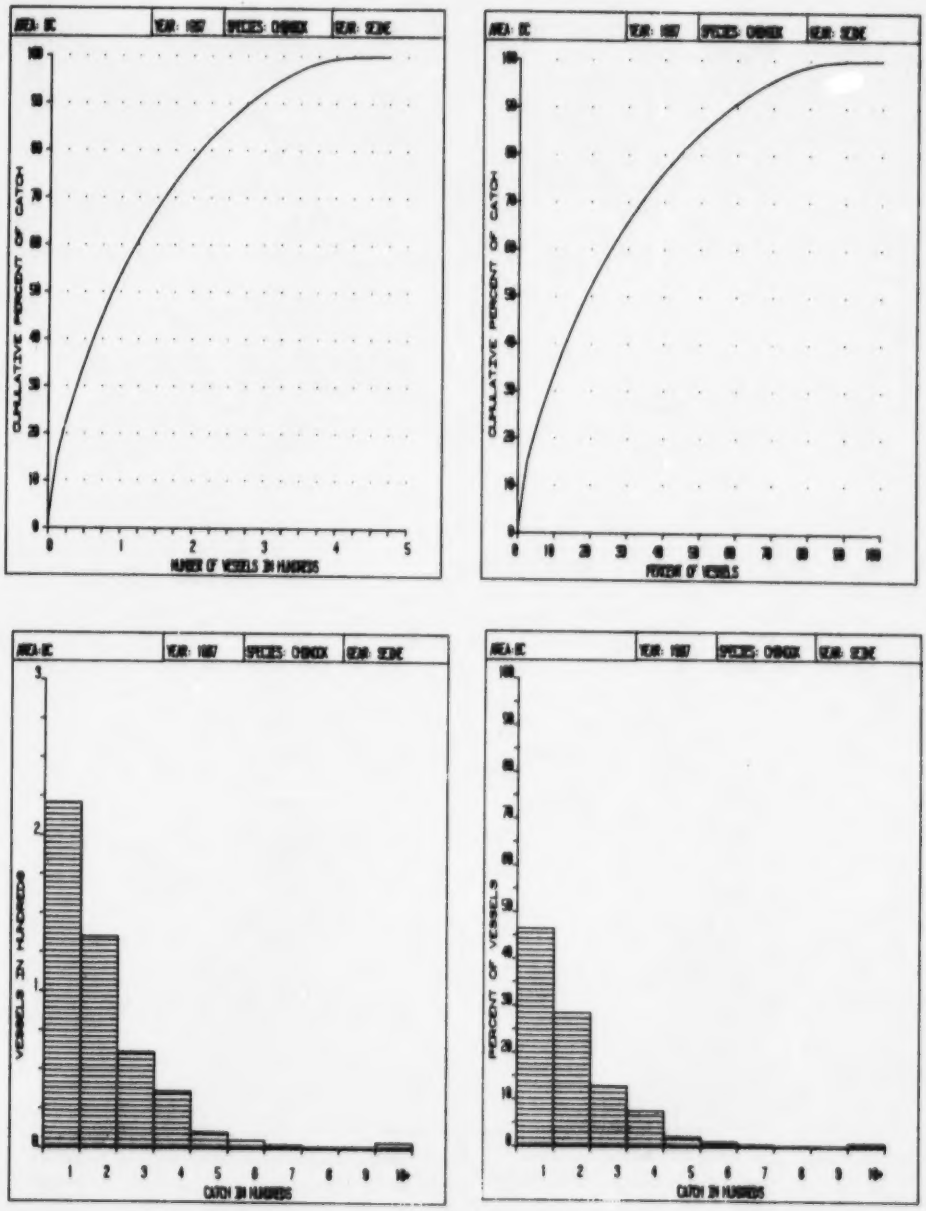

Figure B1. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1967.

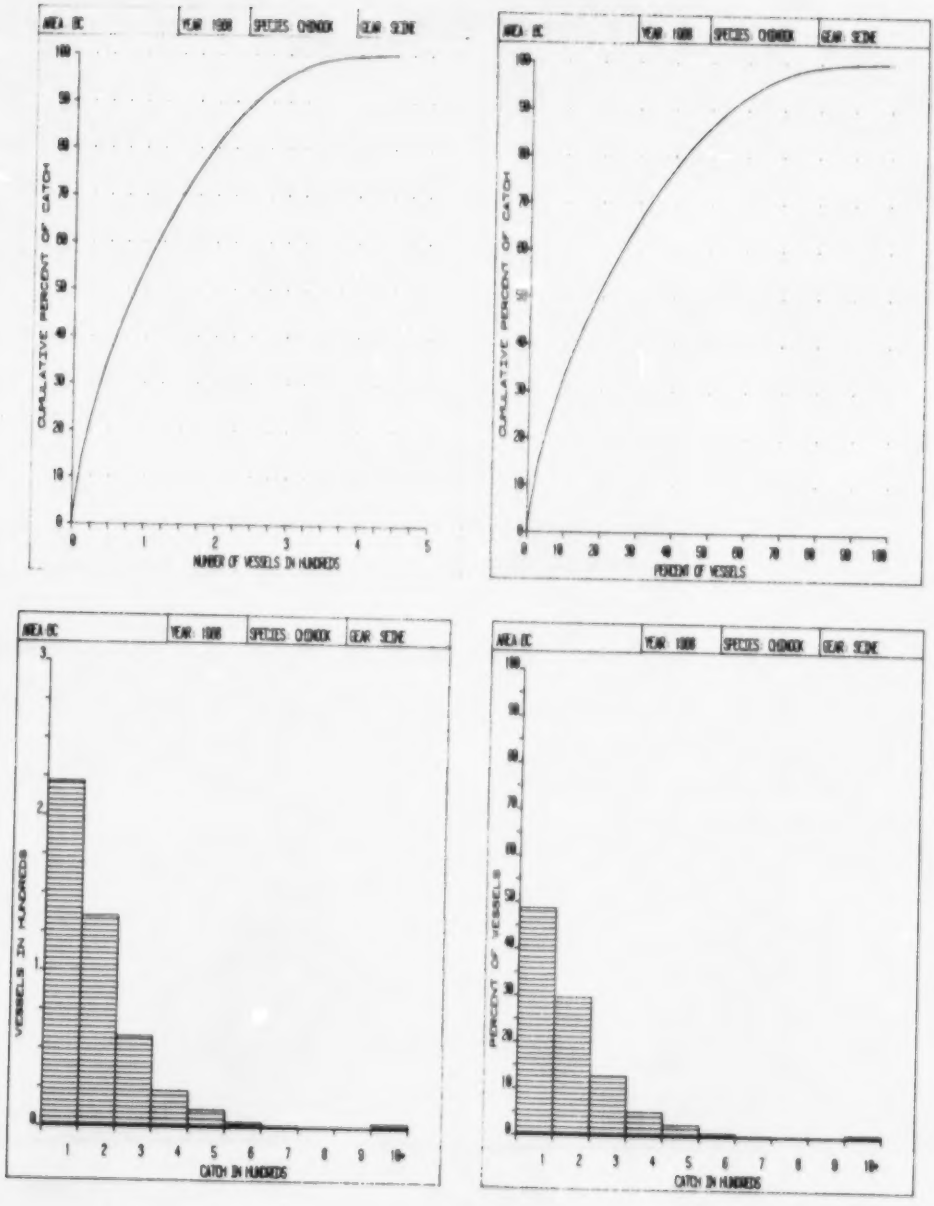

Figure B2. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1968.

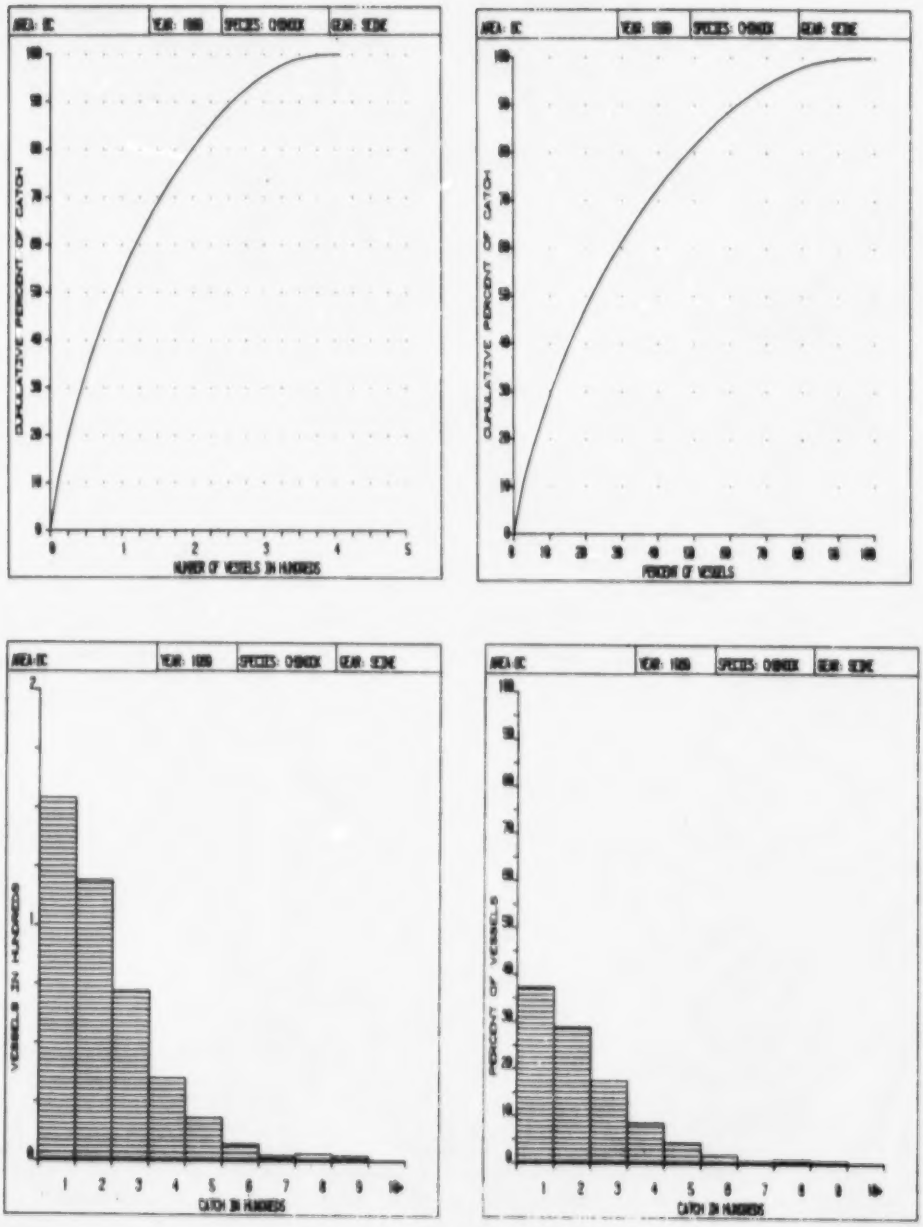

Figure B3. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1969.

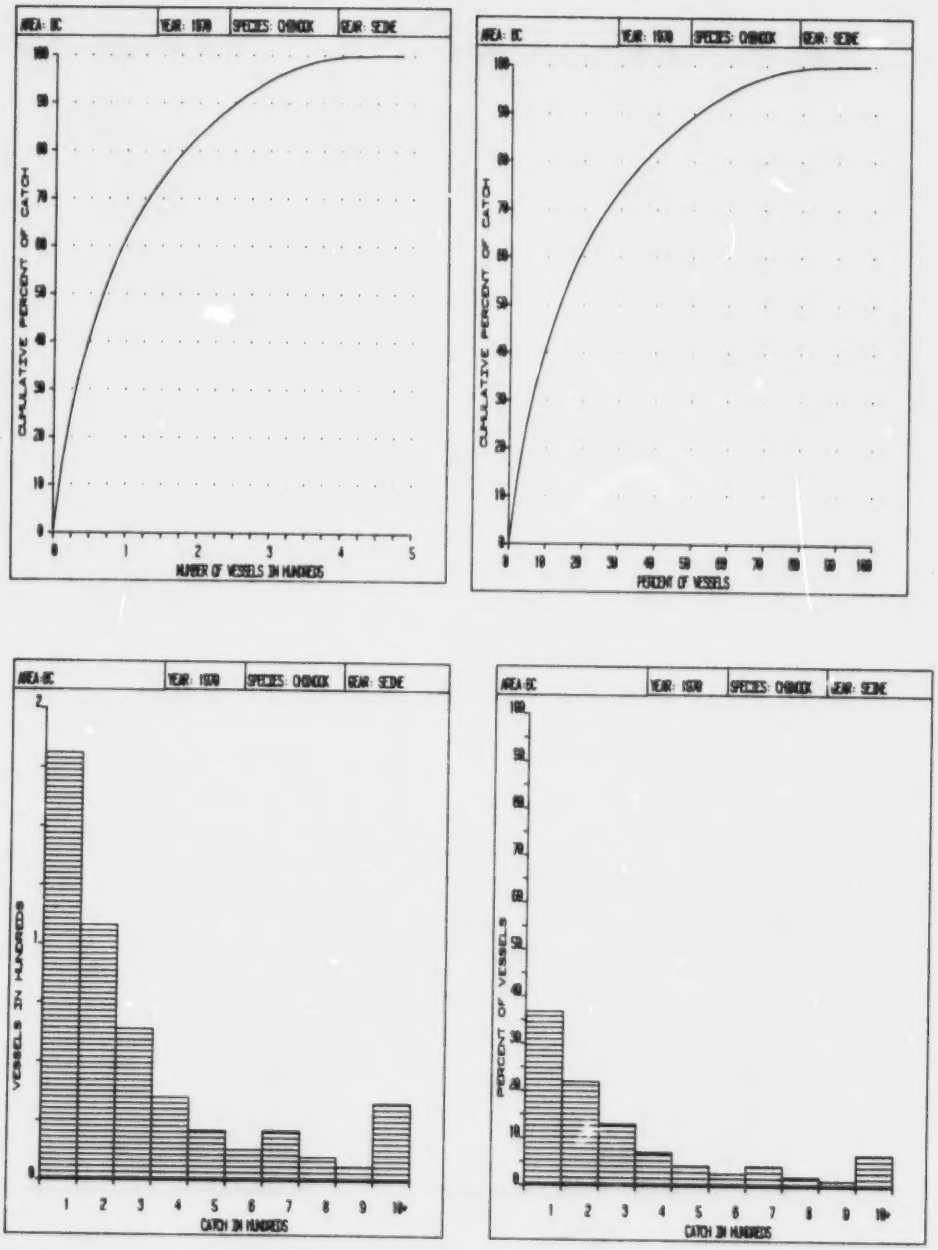

Figure B4. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1970.

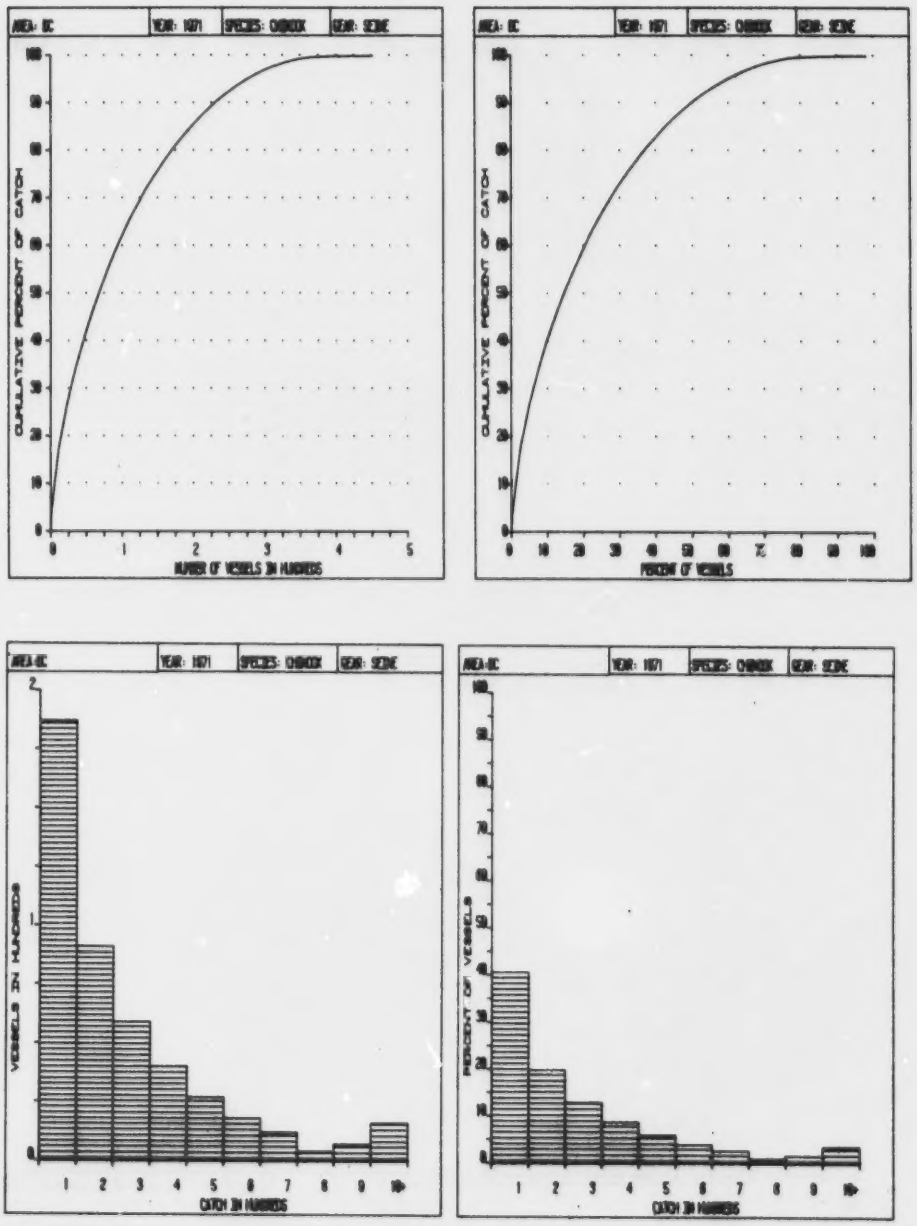

Figure B5. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1971.

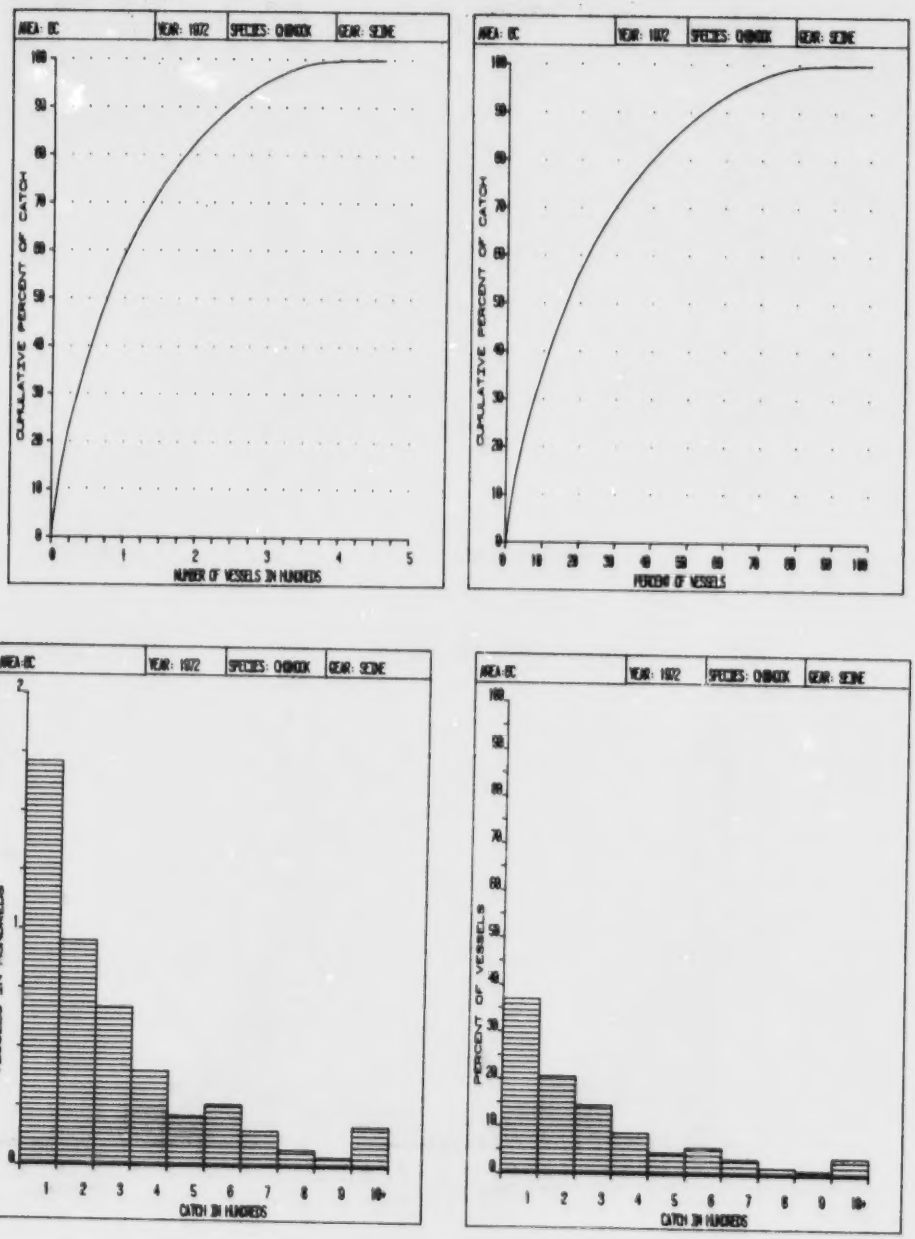

Figure B6. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1972.

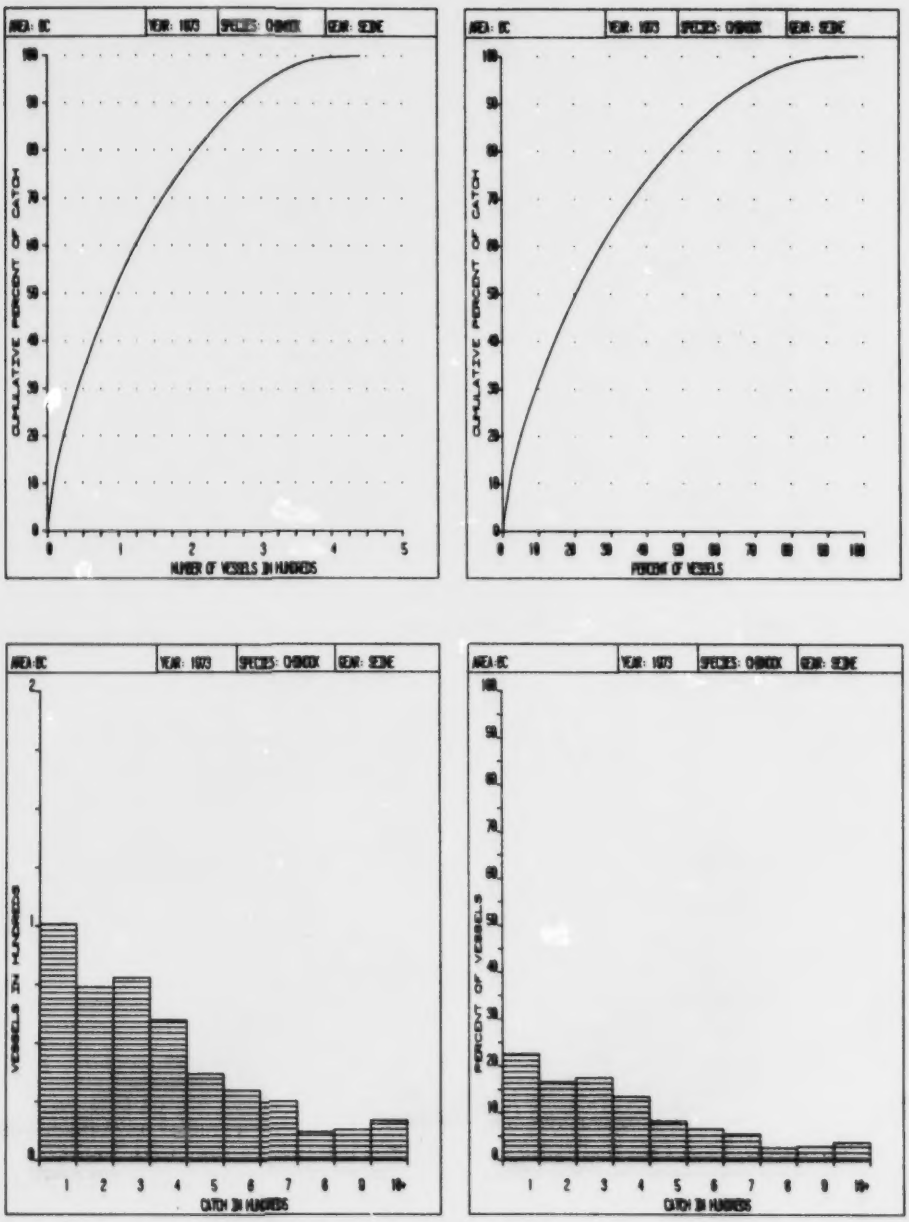

Figure B7. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1973.

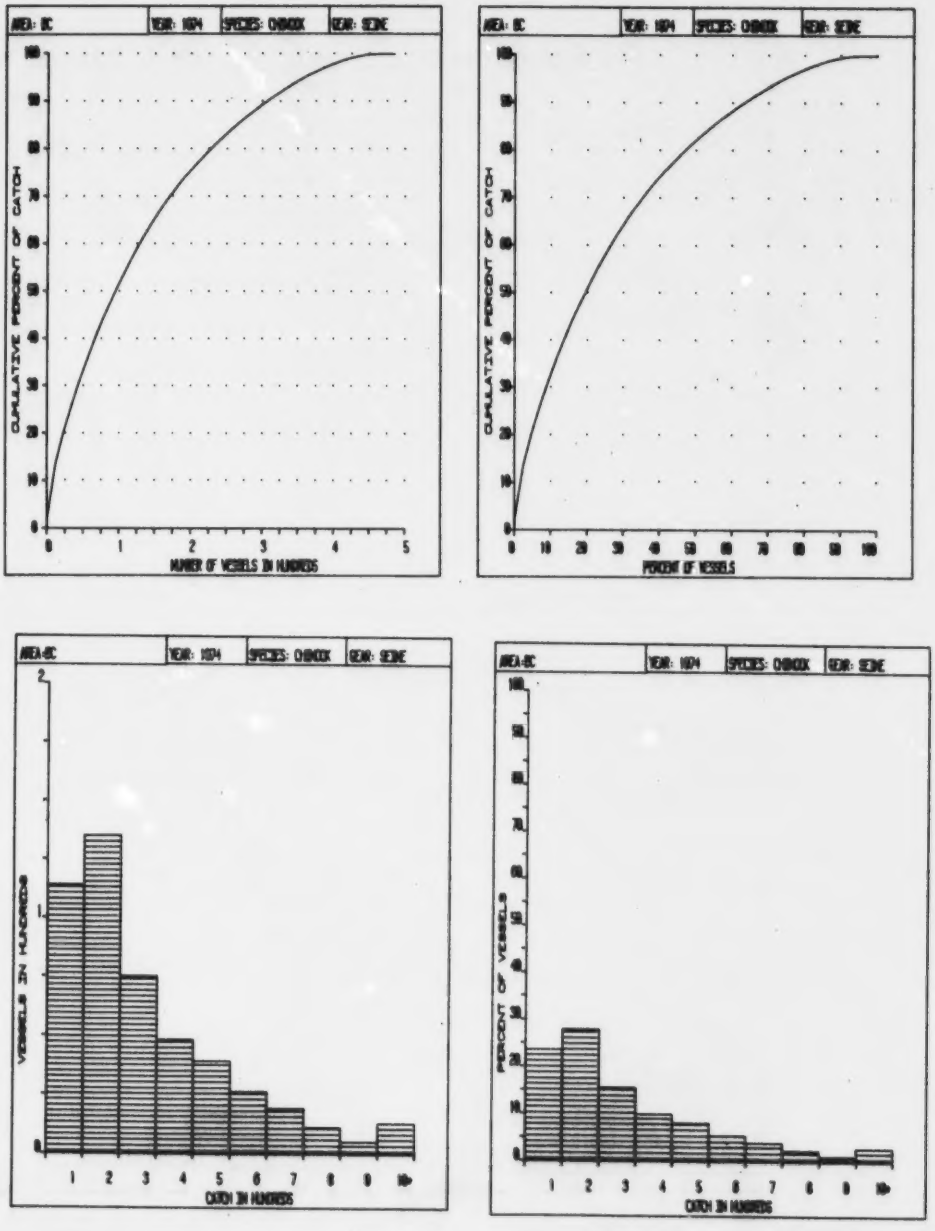

Figure B8. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1974.

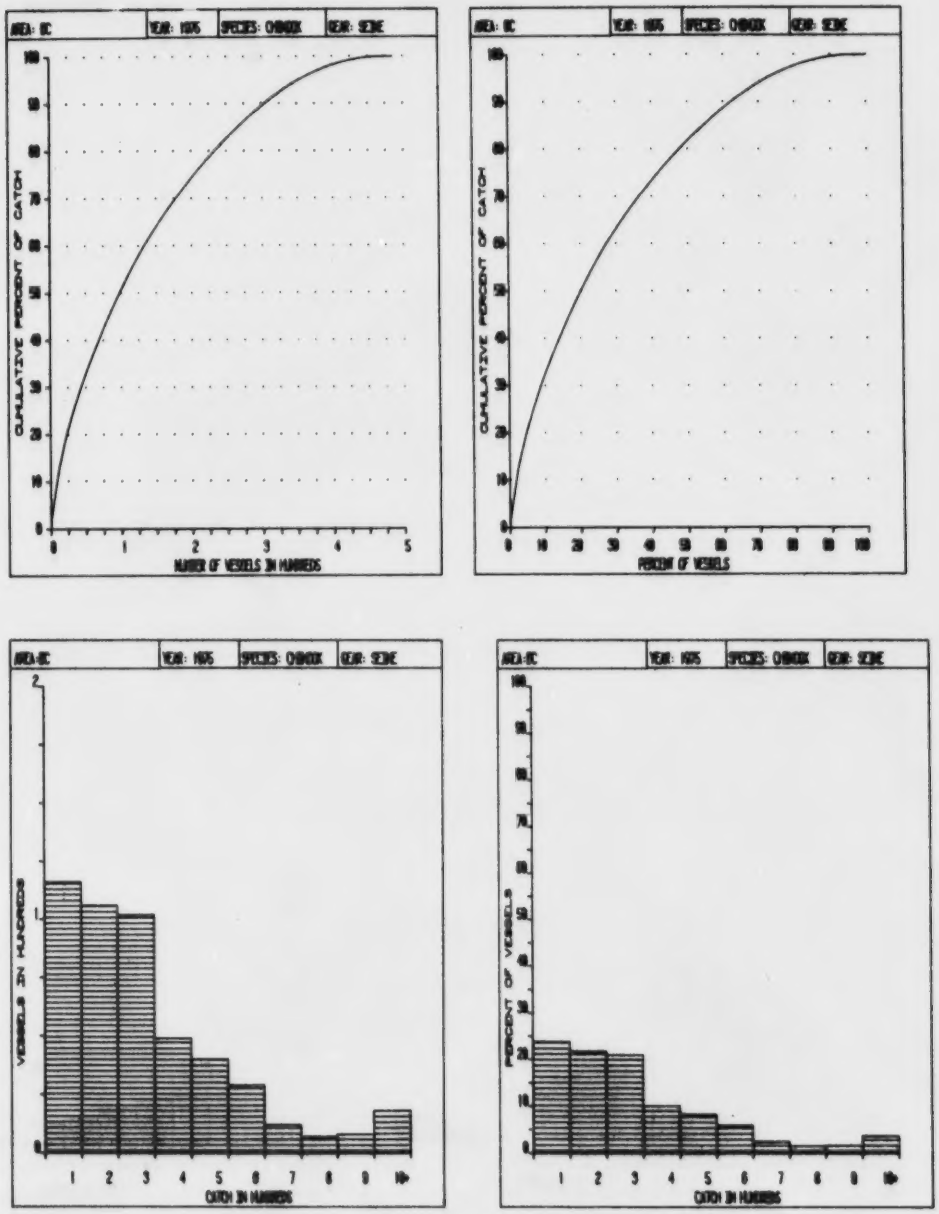

Figure B9. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1975.

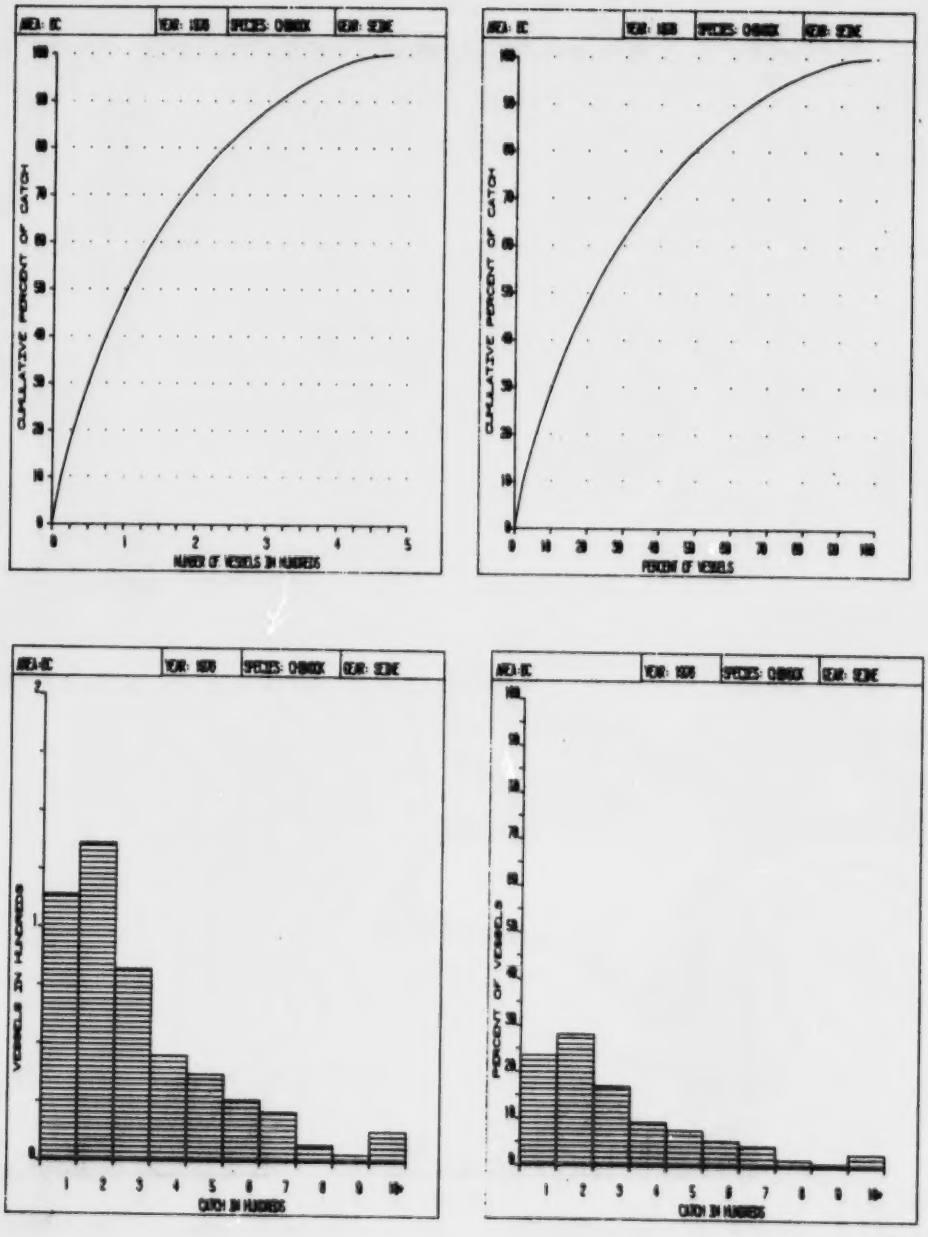

Figure B10. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1976.

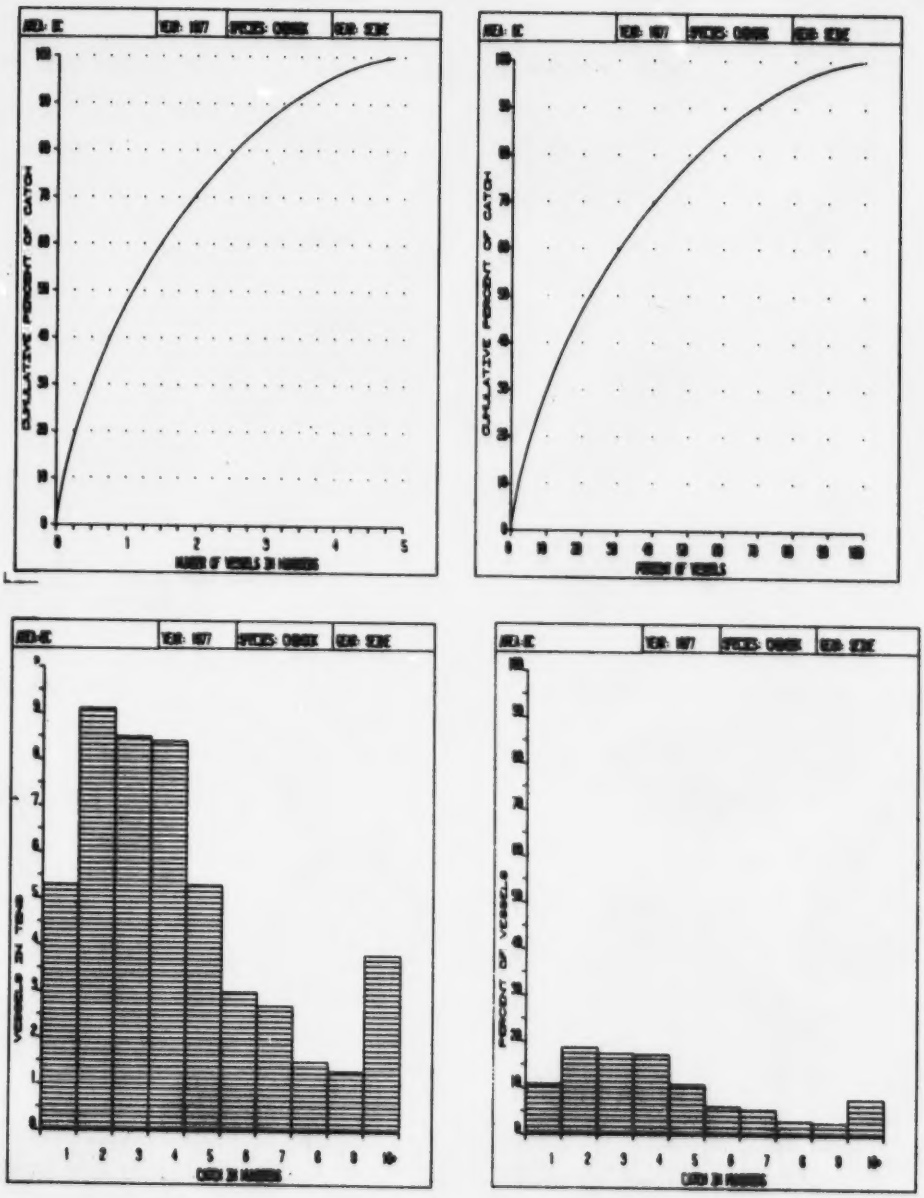

Figure B11. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1977.

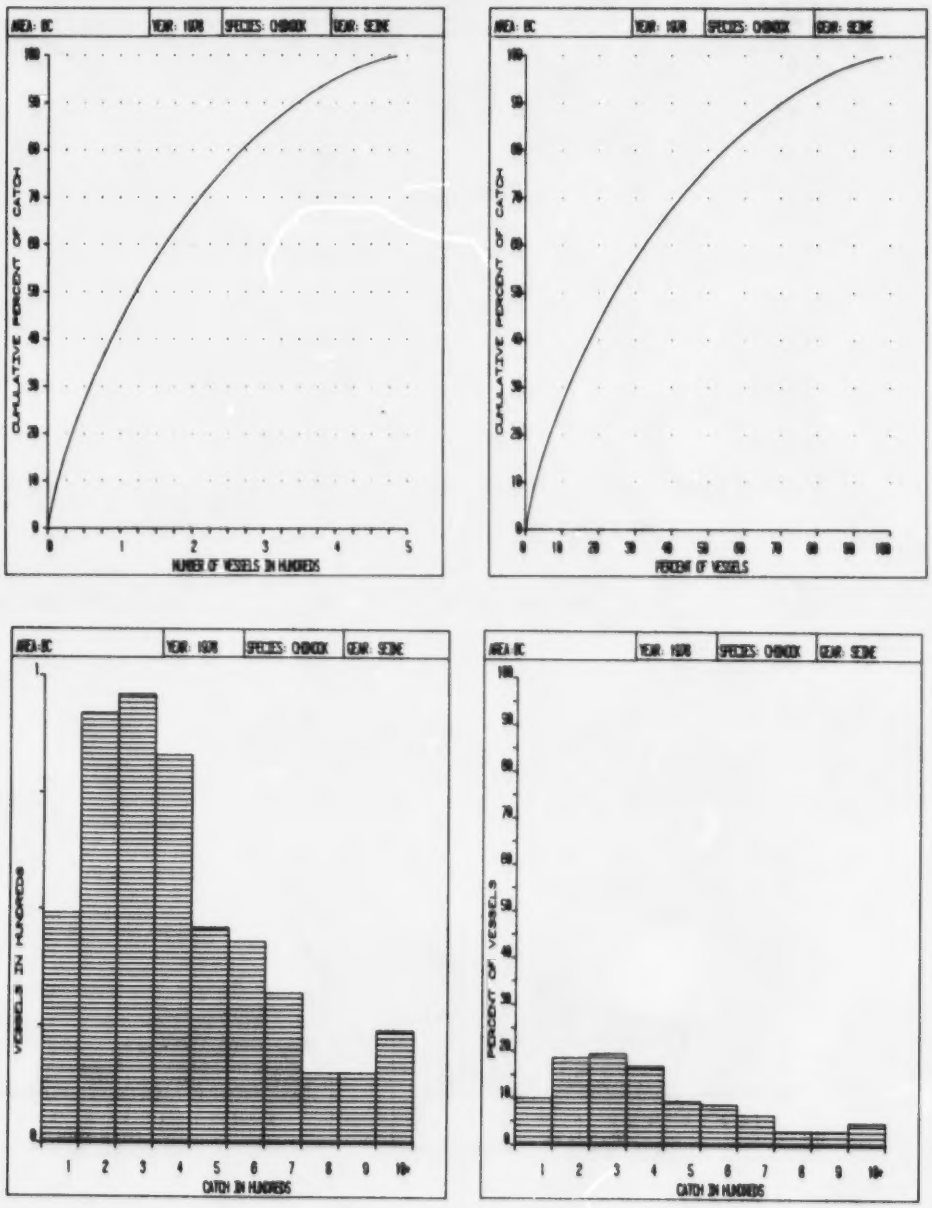

Figure B12. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1978.

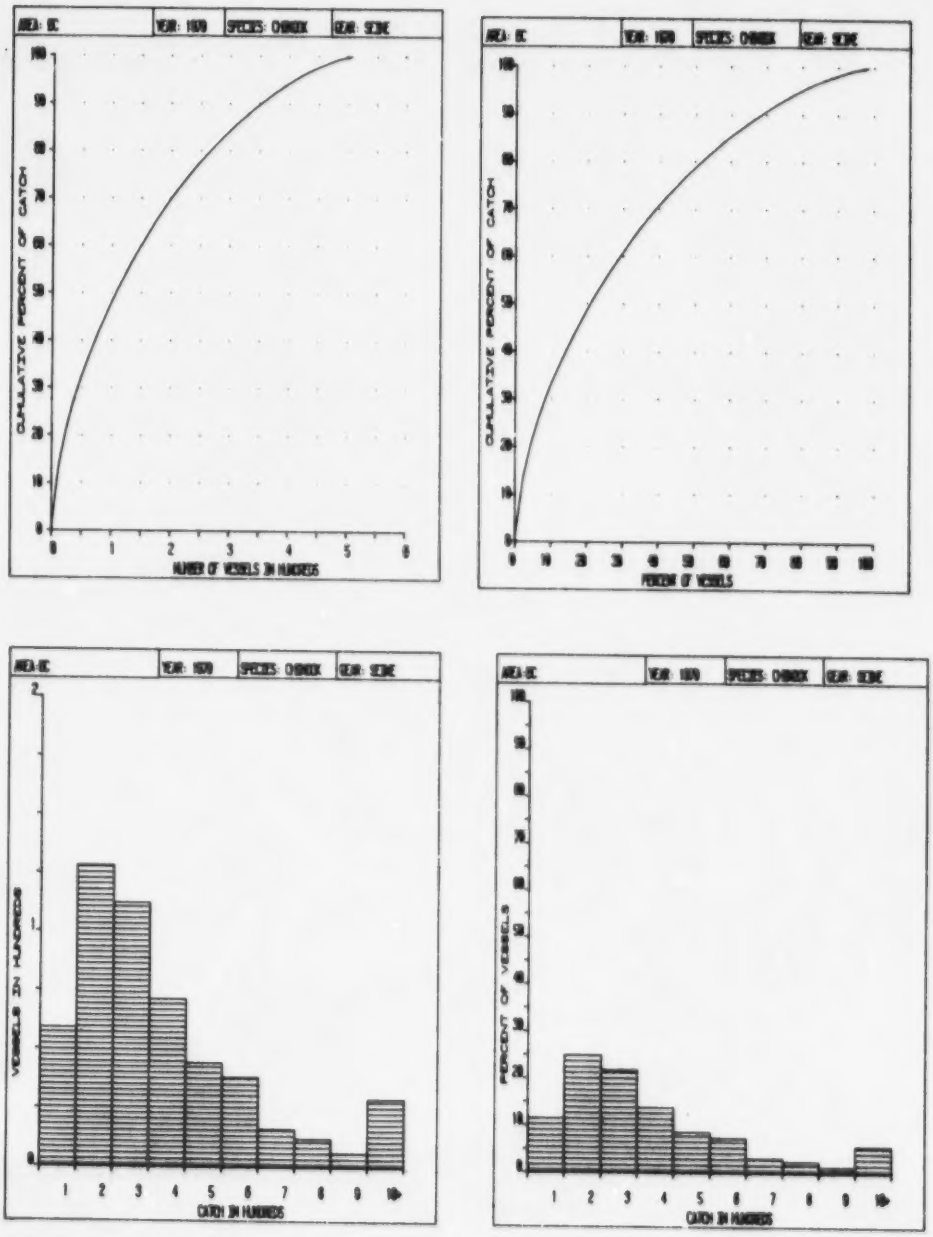

Figure B13. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1979.

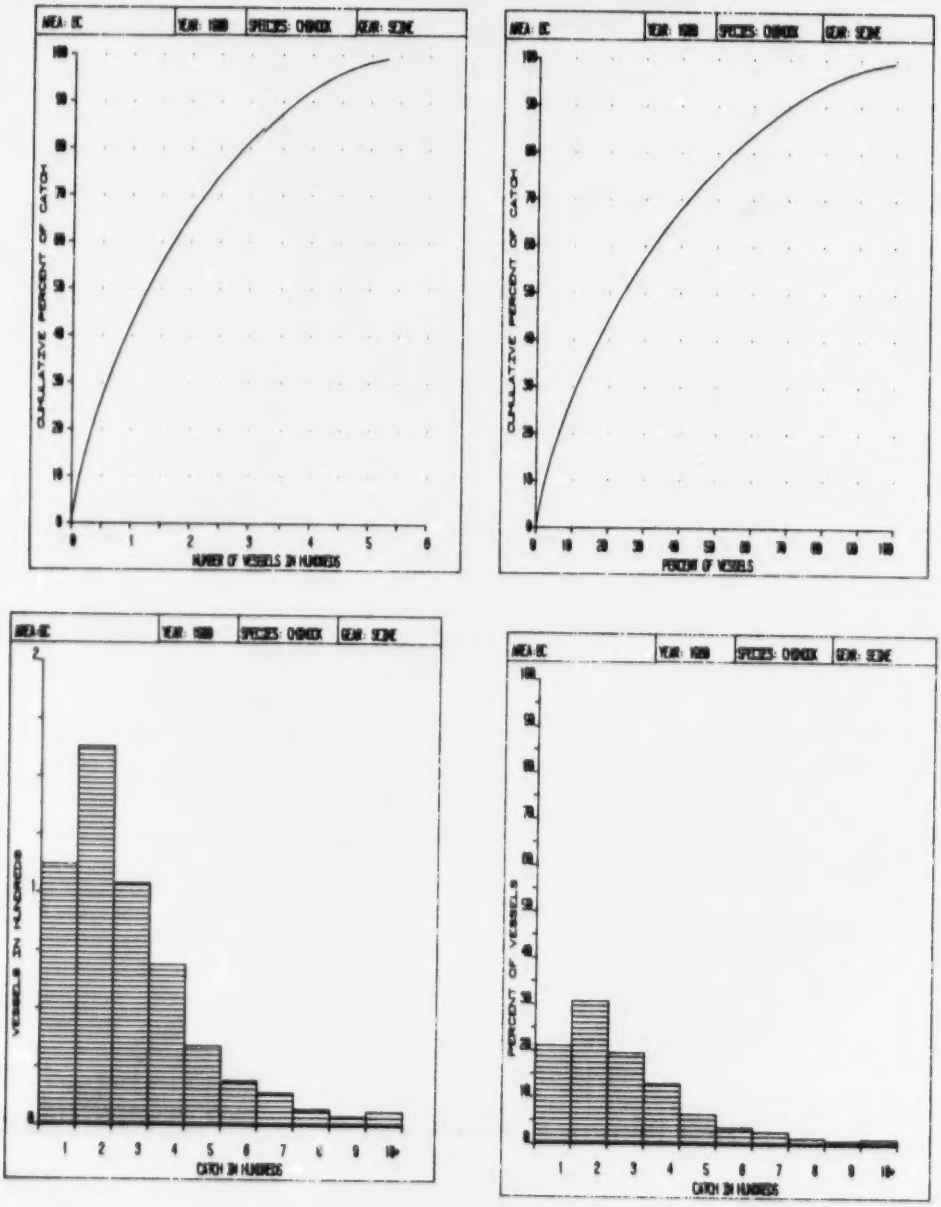

Figure B14. Cumulative percent and frequency of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1980.

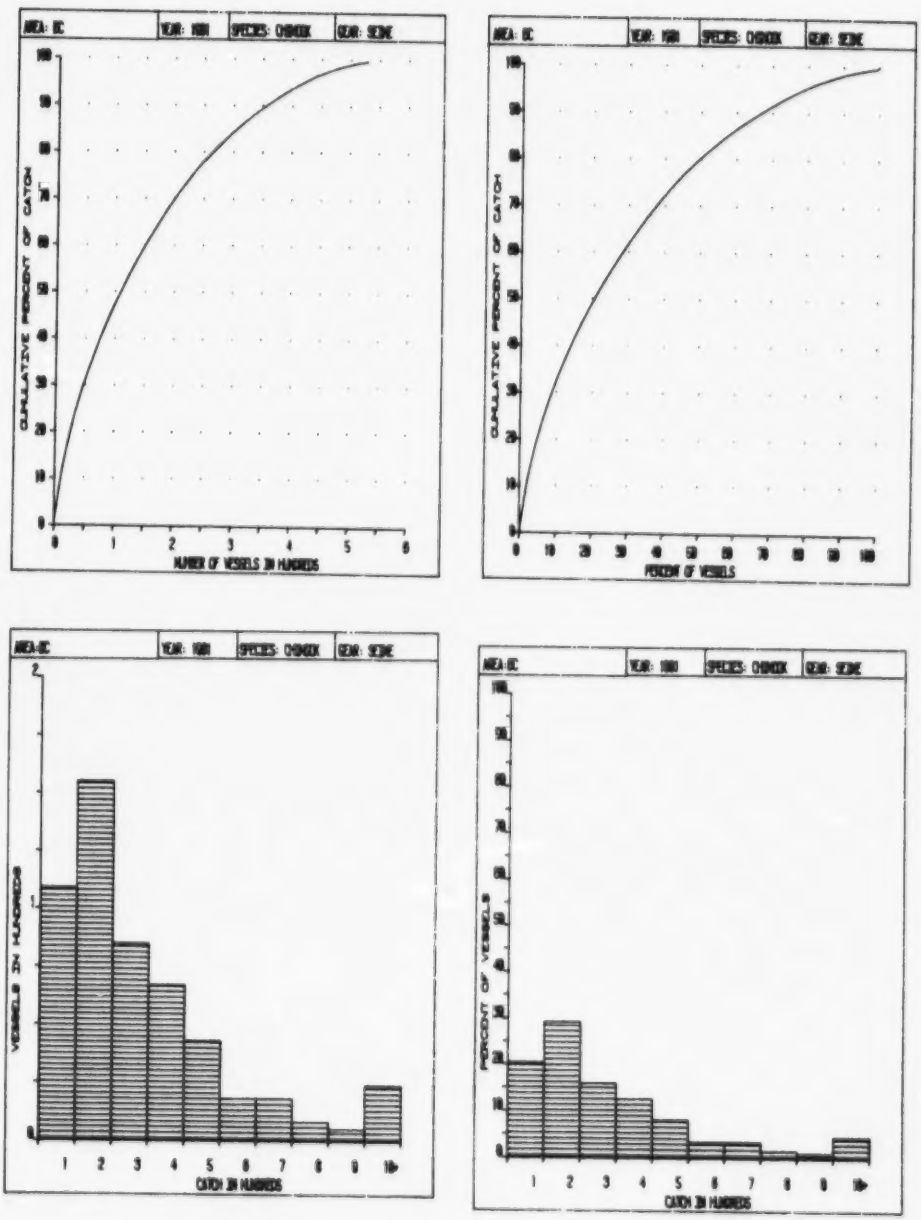

Figure B15. Cumulative percent and freqeuncy of catch of chinook salmon versus number and percent of purse seiners that participated in the fishery, 1981.

APPENDIX C

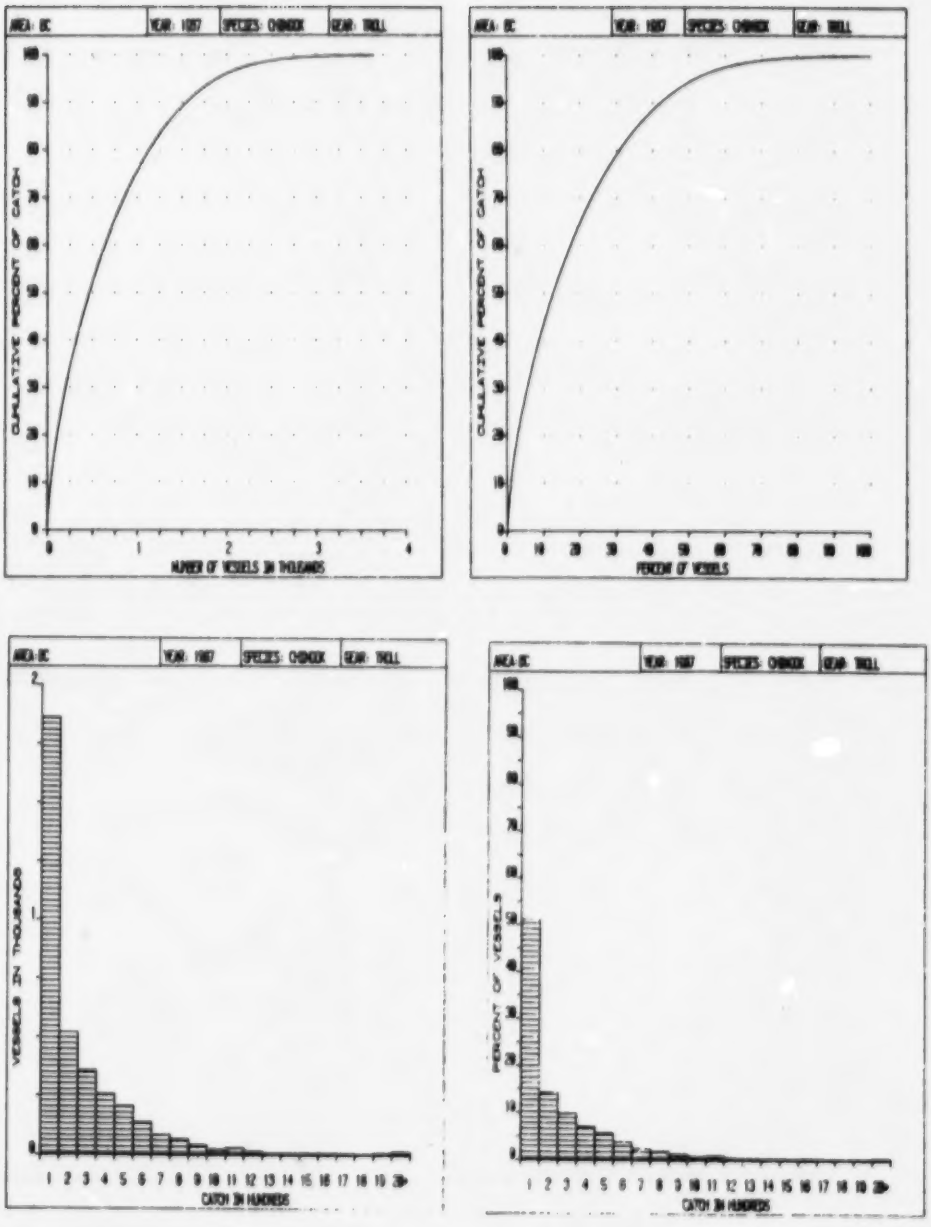

Figure C1. Cumulative percent and frequency of cahtch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1967.

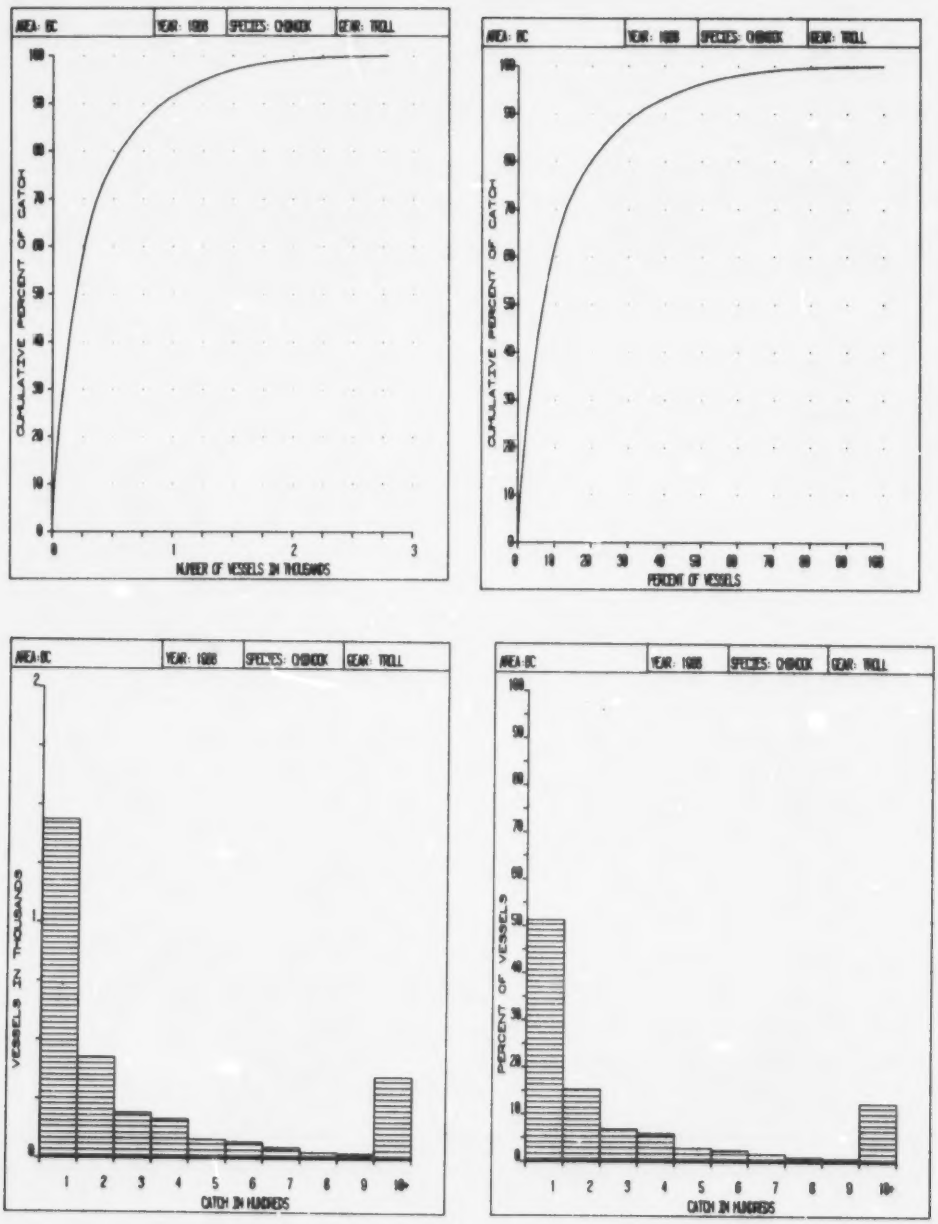

Figure C2. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1968.

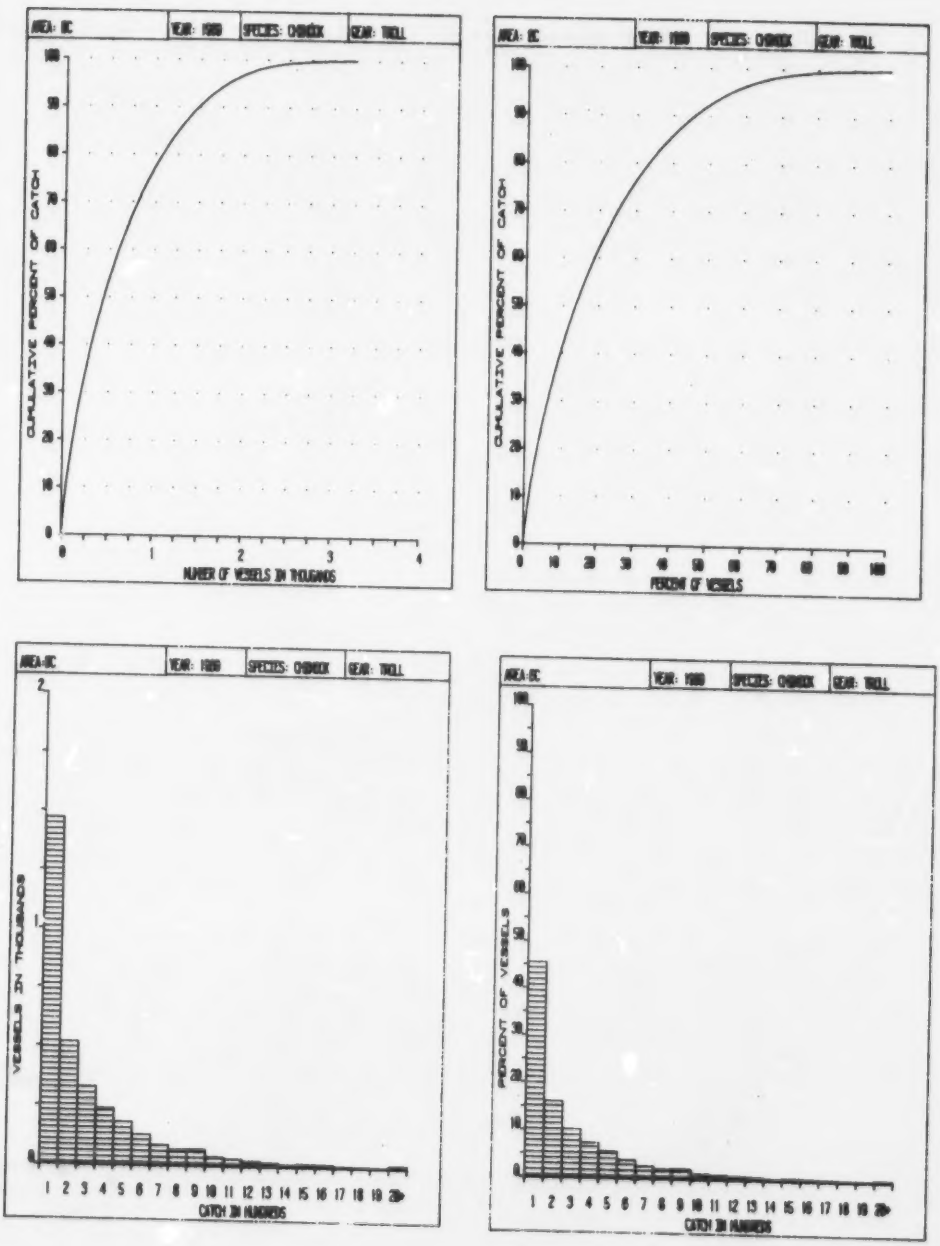

Figure C3. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1969.

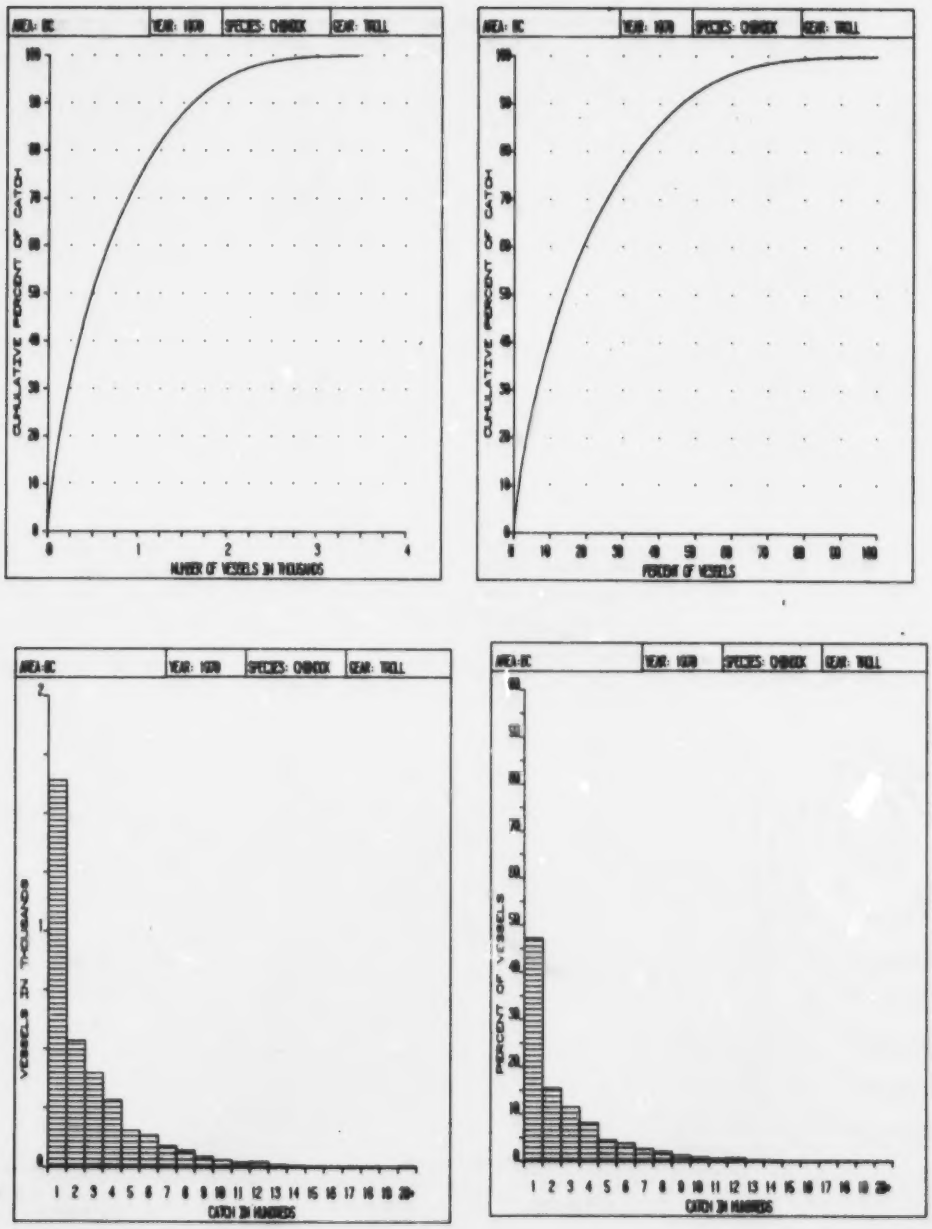

Figure C4. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1970.

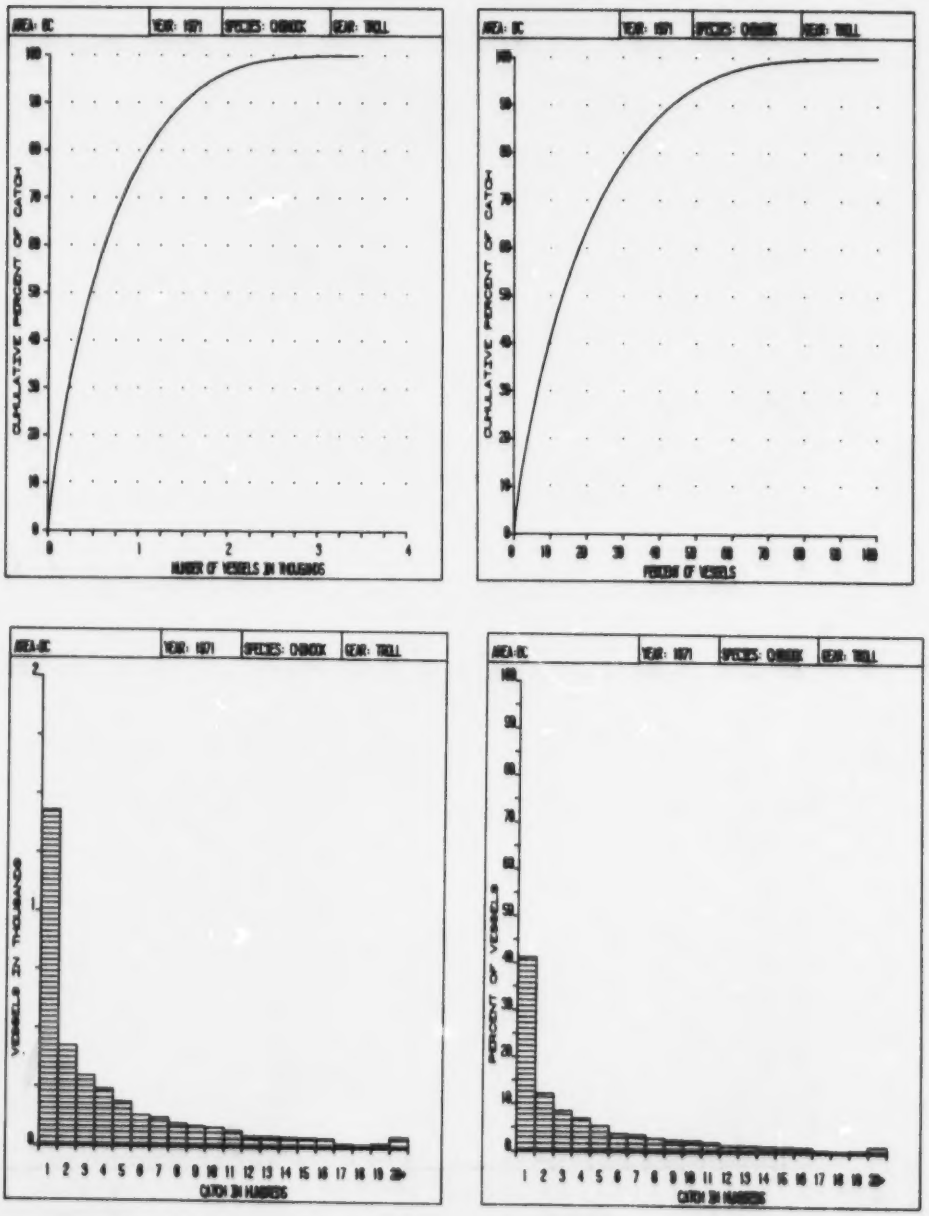

Figure C5. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1971.

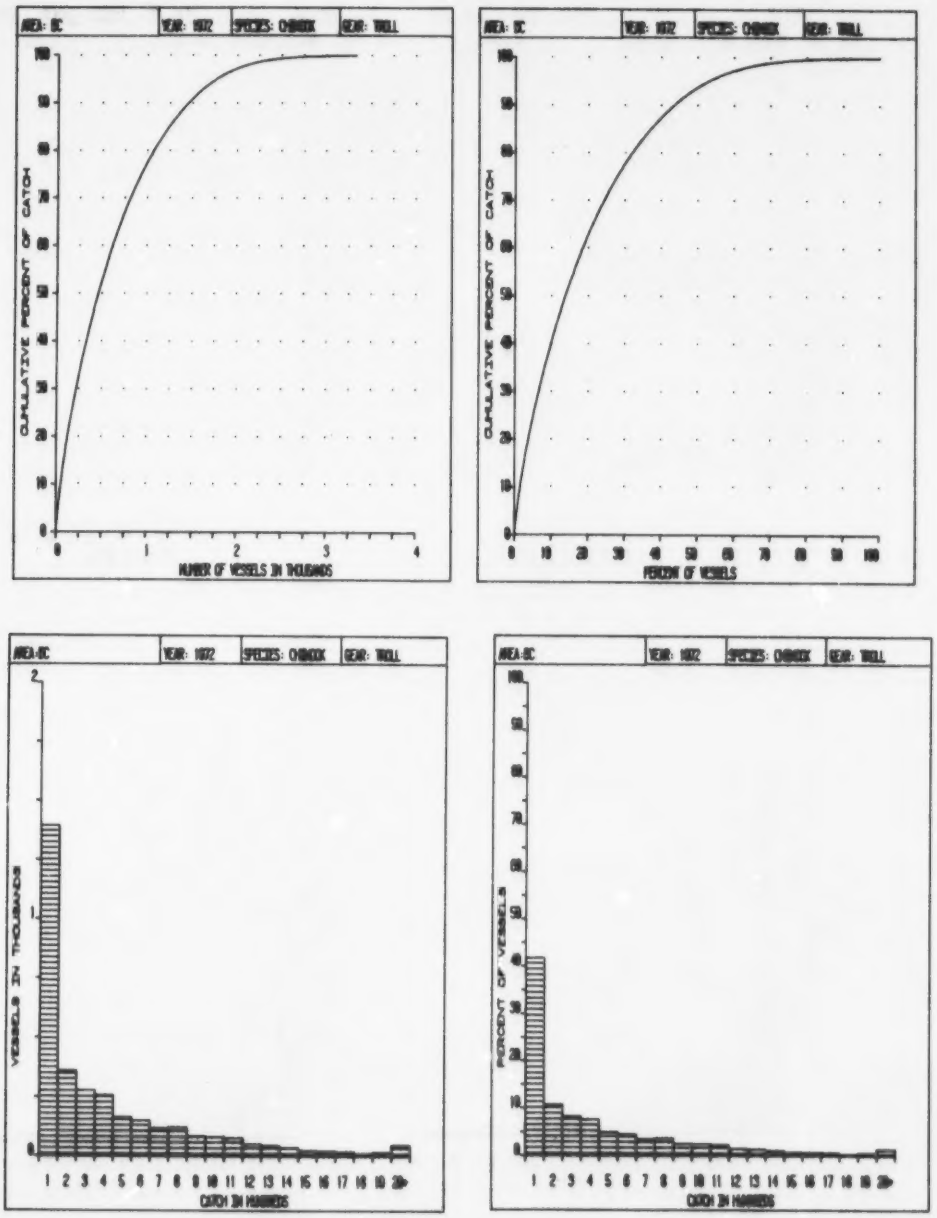

Figure C6. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1972.

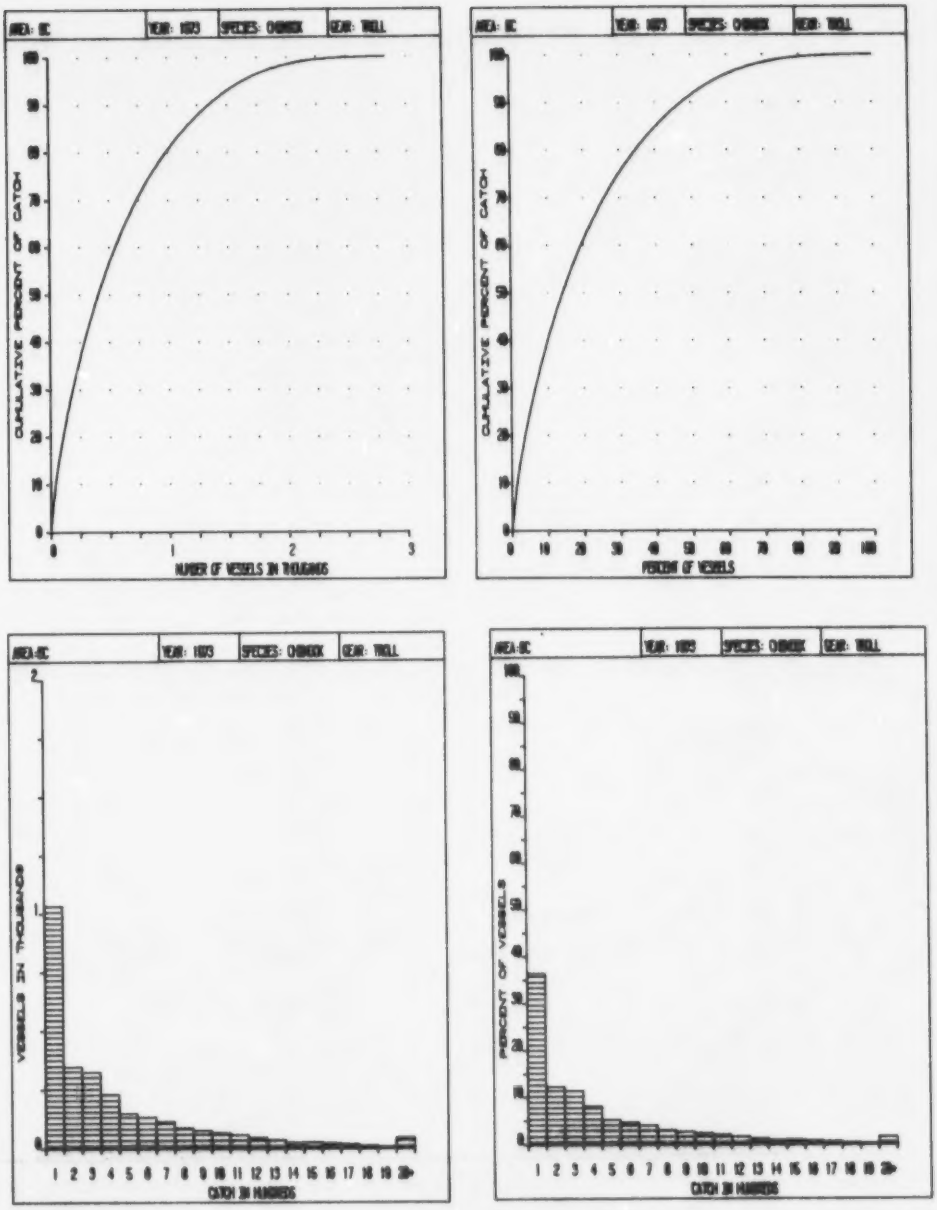

Figure C7. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1973.

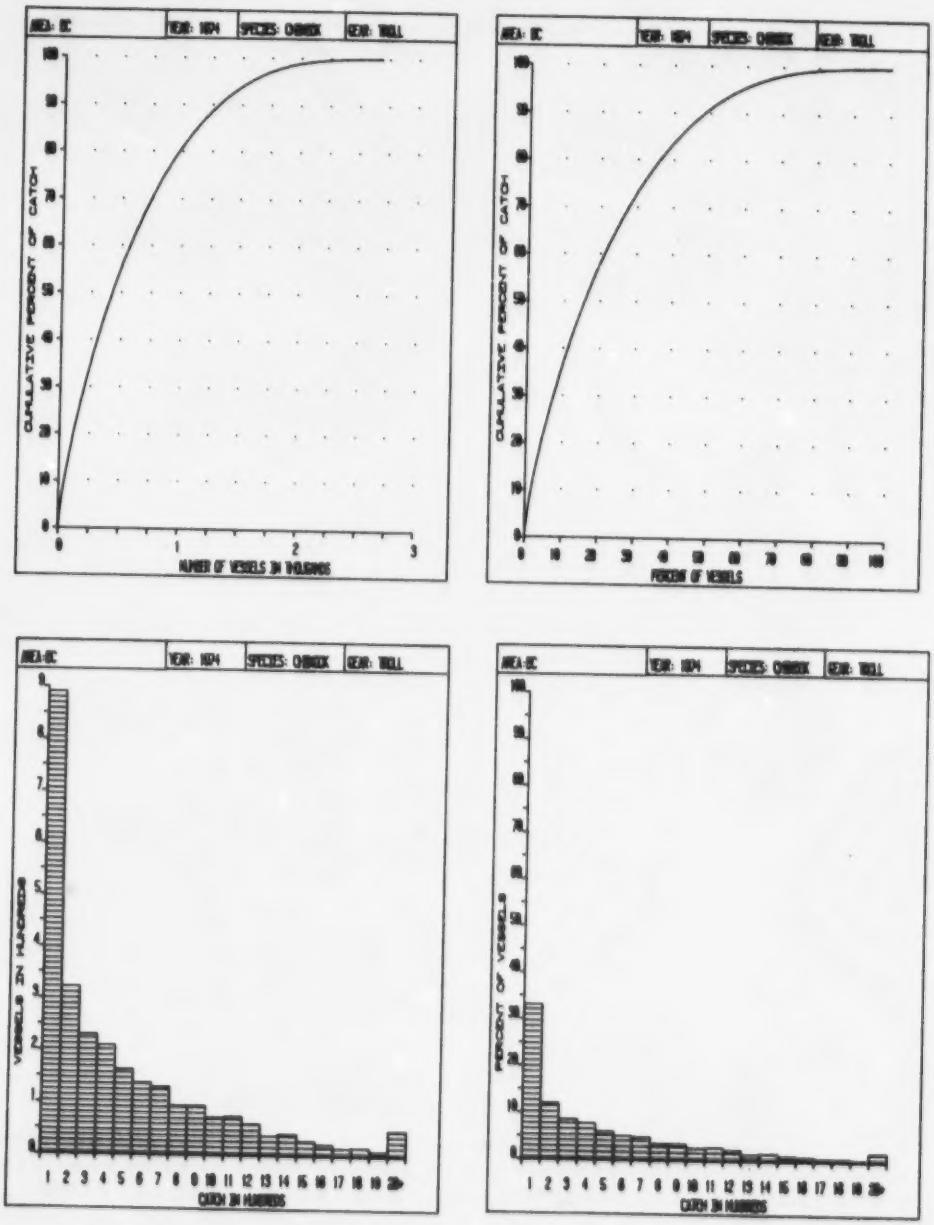

Figure C8. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1974.

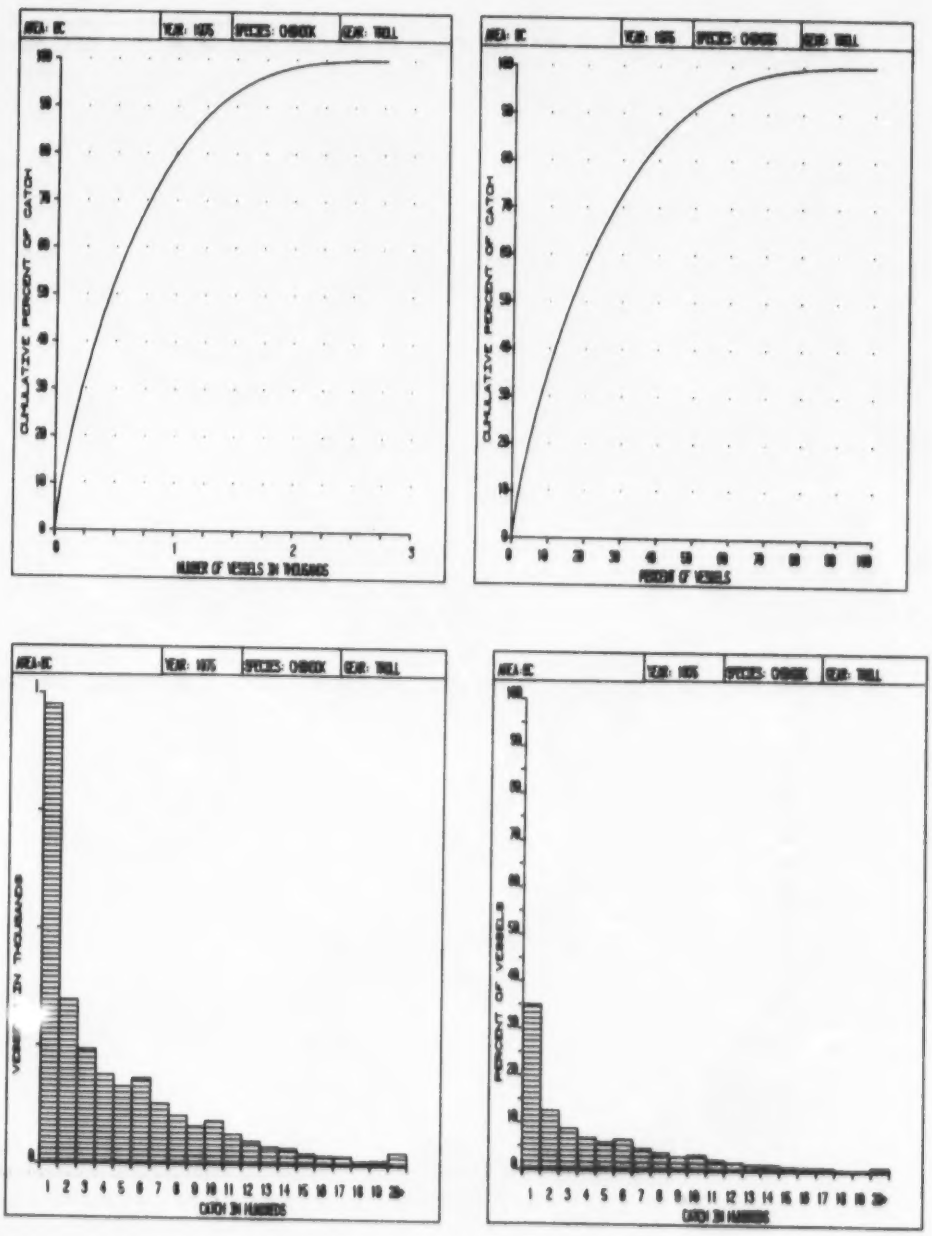

Figure C9. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1975.

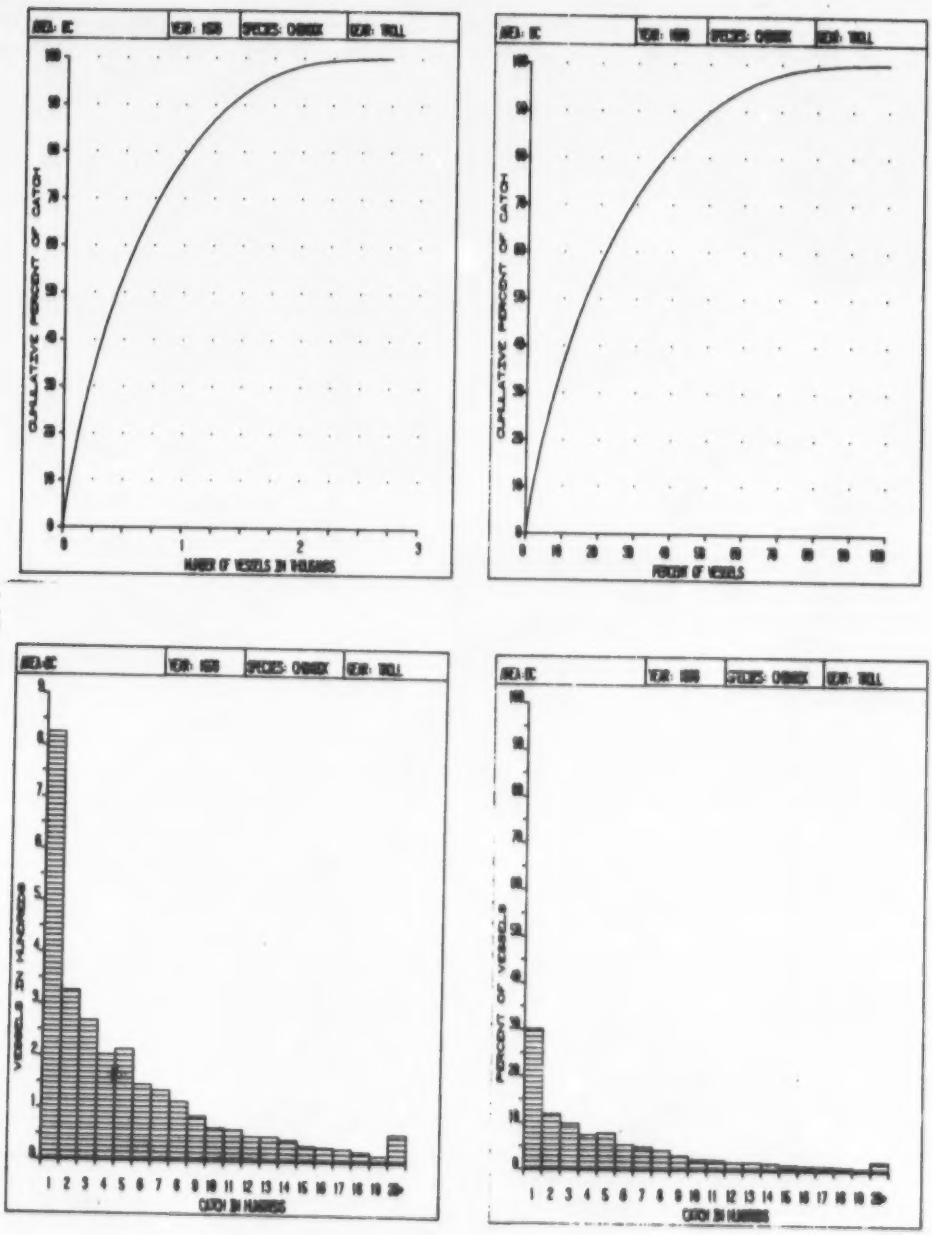

Figure C10. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1976.

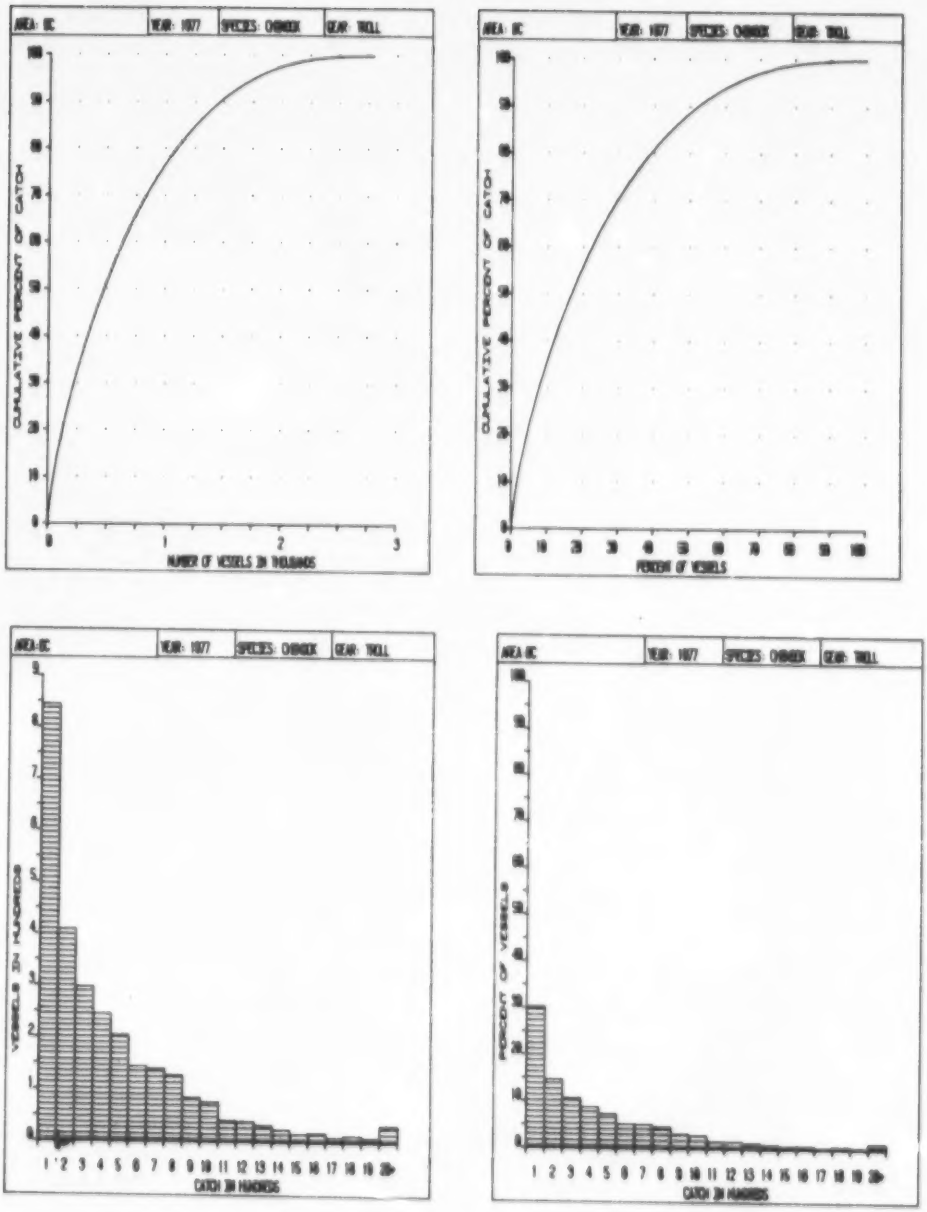

Figure C11. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1977.

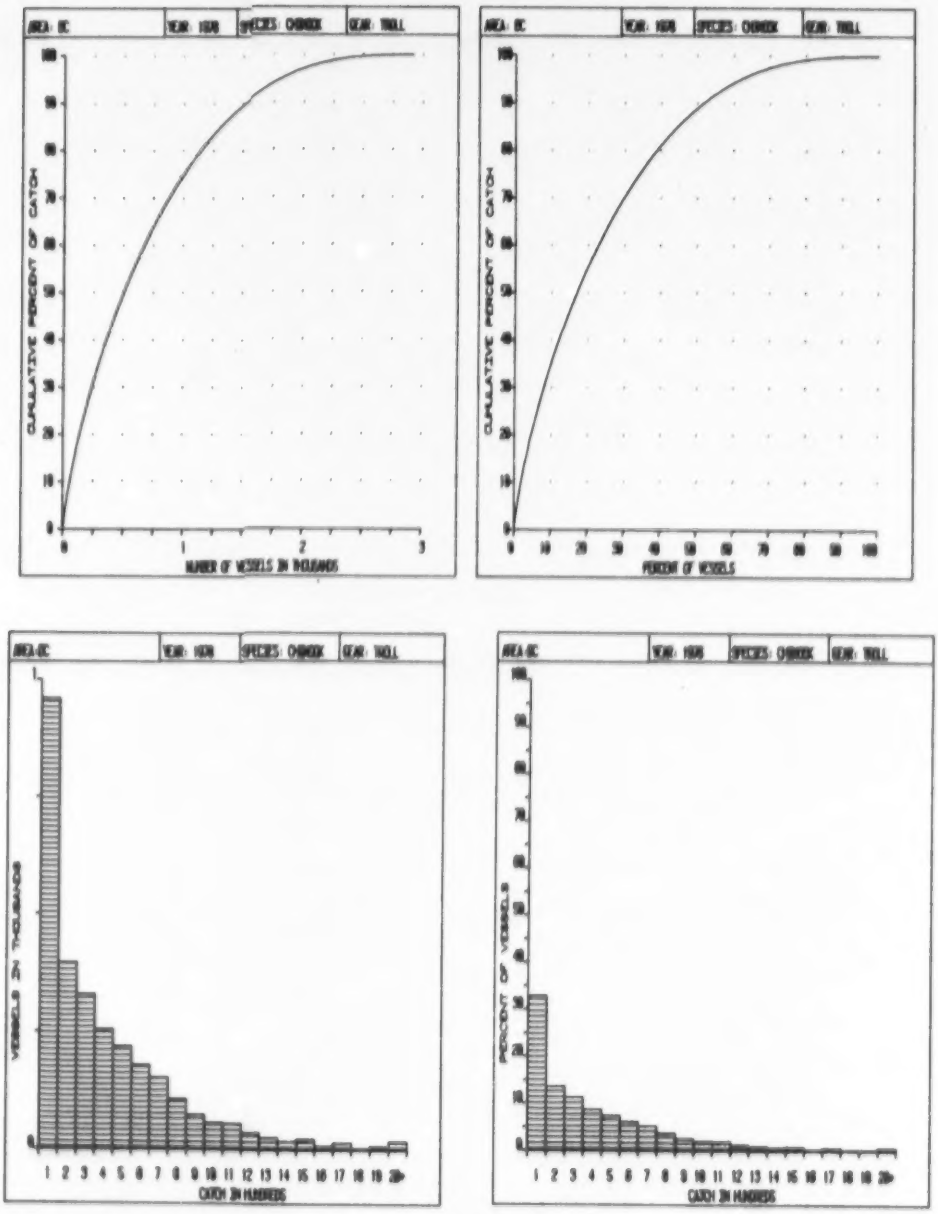

Figure C12. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1978.

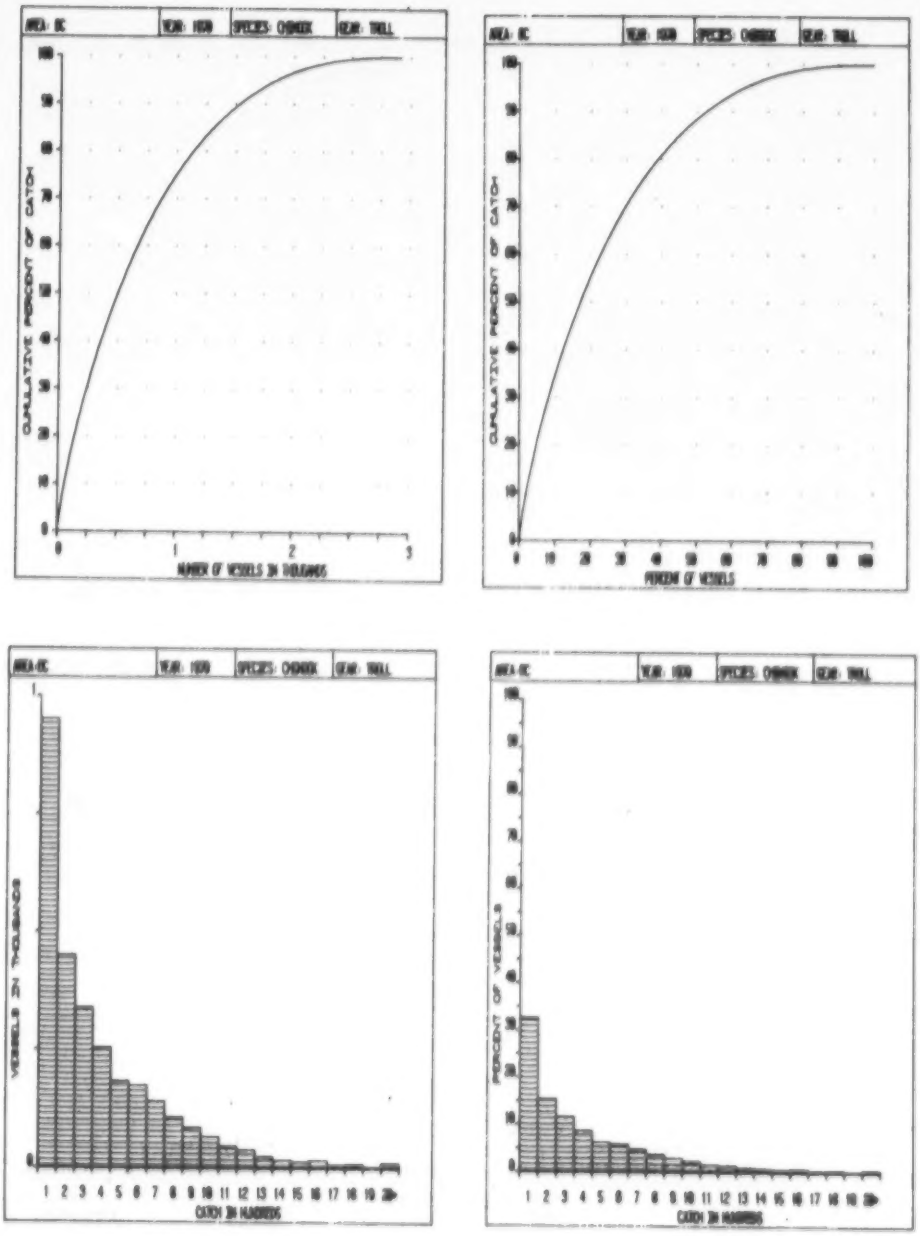

Figure C13. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1979.

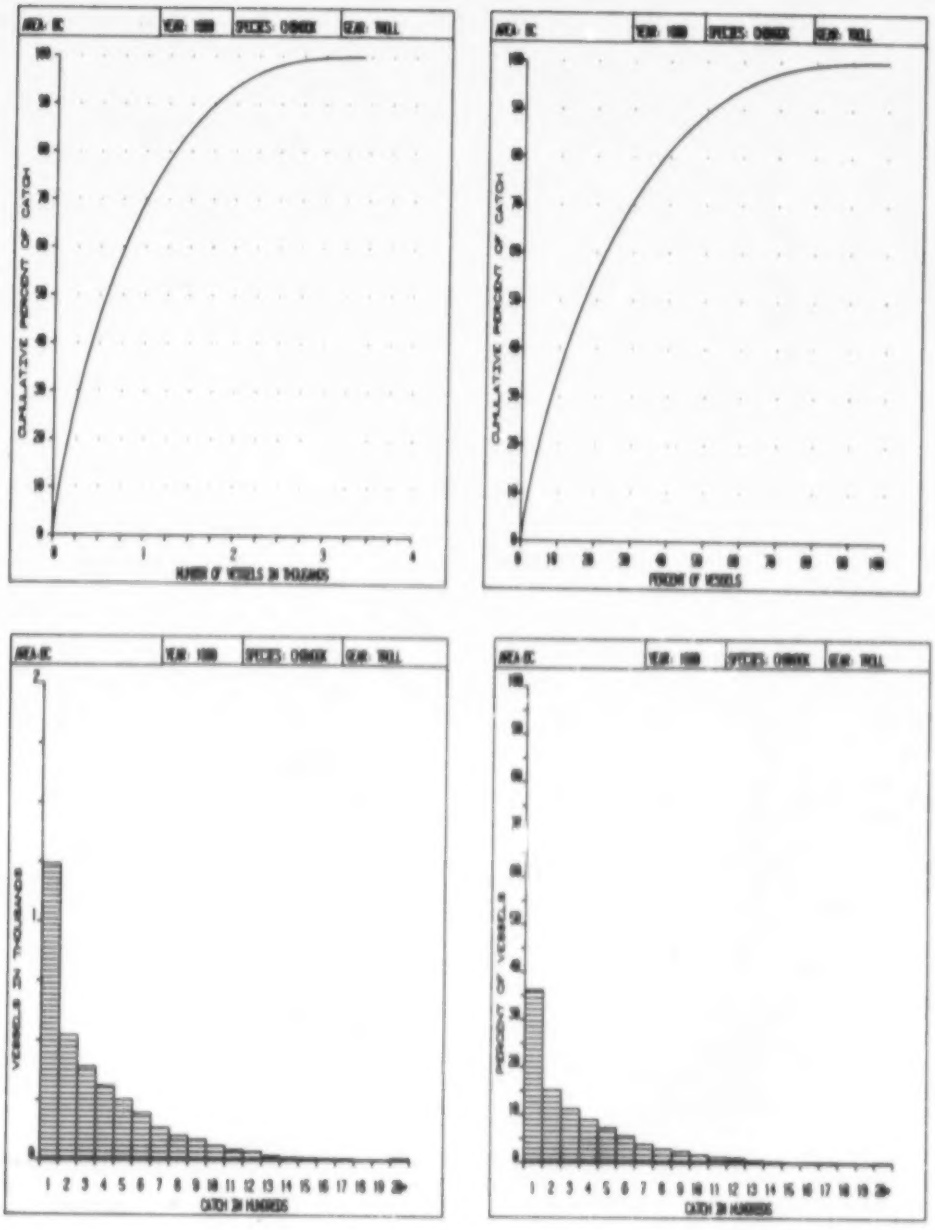

Figure C14. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1980.

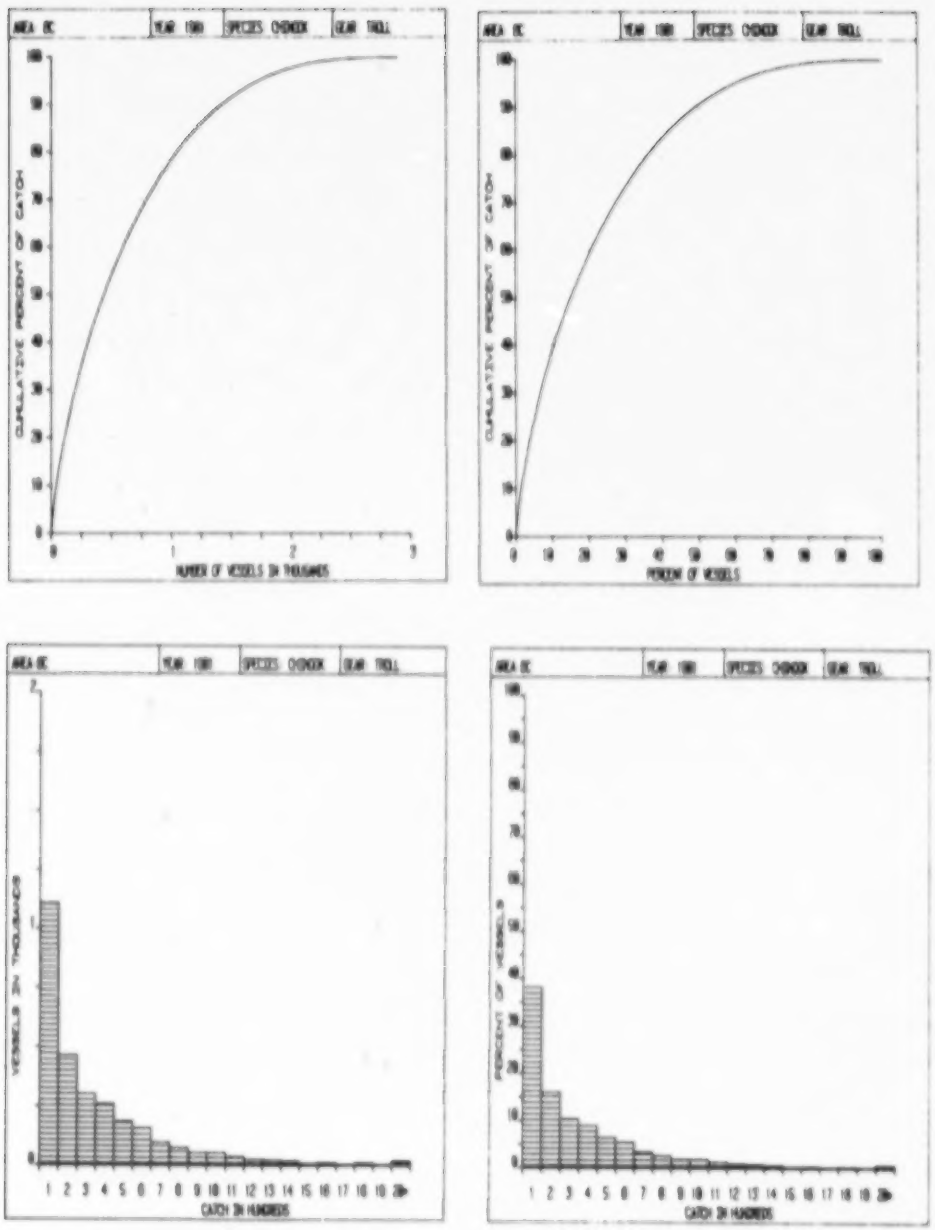

Figure C15. Cumulative percent and frequency of catch of chinook salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1981.